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MISCELLANEOUS SPECIES OF AULACASPIS (STERNORRHYNCHA: COCCOIDEA: DIASPIDIDAE)

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Abstract

TAKAGI, S., 2018. Miscellaneous species of *Aulacaspis* (Sternorrhyncha: Coccoidea: Diaspididae). *Ins. matsum. n. s*. 74: 37–78, 20 figs.

Nine species of *Aulacaspis* are treated under four subtitles. 1) *A. connari*, n.sp., from Luzón, *A. swintoniae*, n.sp., from Malaya, and *A. nephelii* Takagi from Malaya may be referred to the *tubercularis* species group, but they make the group broadened and obscurely bordered. 2) *A. buteae* Takahashi, which was described from Thailand originally and is recorded from Nepal in this paper is characterized in having enlarged microducts forming clusters dorsally on the prosoma, metathorax, and first abdominal segment; *A. connarorum*, n.sp., from Malaya also has enlarged microducts, which are strewn ventrally on the prosoma. 3) *A. bauhiniae* and *A. phanerae*, n.spp., are described from Borneo but, as a possibility, they may belong to a large variable population occurring across the island, representing extreme local forms of the latter. 4) *A. robusta* Takahashi has been known from Taiwan and is recorded from Borneo in the present paper, but there are between the Taiwan and Borneo forms some differences which are to be explained; *A. projecta* Takagi, which has been known from Japan and southern continental China, is recorded from Taiwan, and comparisons made among samples from Taiwan and Japan suggest that this species, too, is considerably variable.

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Contents

*Scientific paper for the united projects: Hokkaidô University Expeditions to the Himalaya; Research Trips for Agricultural and Forest Insects in the Subcontinent of India; Systematic and Ecological Surveys on Some Plant-parasitic Microarthropods in Southeast Asia.

Introduction

In this paper, nine species of *Aulacaspis* are treated under four subtitles. Under the first subtitle, three species are tentatively referred to the *tubercularis* group, but they make the group broadened and obscurely bordered. Under the second, two species, which are not particularly closely related to each other, are noteworthy in having enlarged microducts dorsally on the prosoma, metathorax, and the first abdominal segment or ventrally on the prosoma. Thirdly, two species occurring at distantly separated localities in Borneo are apparently closely related to each other and distinguished by an obvious difference in a certain feature, whereas an external case of variation applied to that feature and the patterns of variation in other features suggest the possibility that they represent extreme local forms belonging to a large variable population occurring across the island. Under the fourth subtitle, two species are also variable, and each of them presents another example for the problem of allopatry and taxonomic treatment.

Terms. The term 'trullae' is adopted in place of 'pygidial lobes' in authors. The term 'dorsal macroducts' is applied to the combined submedian and submarginal macroducts, excluding the marginal macroducts. (The marginal macroducts are, in *Aulacaspis*, stable in number and arrangement: one on the third abdominal segment, two on each of the fourth to sixth, and one on the seventh, except for rare abnormal cases). The abbreviations 'abd I', 'abd II', and so on stand for abdominal segments.

Numbers of wax-secreting organs. The numbers of wax organs are given for each side of the body except for the total number of the dorsal macroducts and that of the perivulvar disc pores. For each sample or subsample, the lowest, mean, and highest values or, in some cases, the lowest and highest values or values in individual specimens are given. Sometimes it is hardly possible to count exactly these organs, especially spiracular disc pores, owing to crowding or other conditions, and estimated numbers are given with the mark 'ca.'. The size of a sample or subsample, '*n*', follows in brackets.

Depositories of the holotypes. *Aulacaspis connari*: Museum of Natural History, University of the Philippines at Los Baños, Laguna, the Philippines; *Aulacaspis swintoniae*, *A. connarorum*, *A. bauhiniae*, and *A. phanerae*: Entomology Division, Forest Research Institute, Kepong, Kuala Lumpur, Malaysia.

Three species tentatively referred to the tubercularis group

The *tubercularis* species group of *Aulacaspis* was proposed for eight species (Takagi, 2010). The three species mentioned in this section may be added to the group. They, however, appear to be strange to the group in body shape, certain marginal setae, certain marginal processes on the pygidium, or the basal zygosis of the median trullae.

These three species, all placed tentatively in the *tubercularis* group, will modify the concept of the group, if they are not misplaced. In general, no species groups formed on the basis of morphological features may be discrete and distinct from each other in such a genus as *Aulacaspis*, which is undoubtedly in the midst of copious speciation probably involving many cases of convergence and parallelism and even atavism in morphological change.

Aulacaspis connari, n.sp.
(Fig. 1)

Material examined

Collected at Kinabuhayan, Dolores, Quezon, Luzón, Philippines, on *Connarus semidecandrus* (Connaraceae), 25.XI.1992. Females occurring on leaves, on the lower surface. Nine mounted adult females including the holotype.

Wax-secreting organs

Spiracular disc pores. Not always counted exactly. Associated with each anterior spiracle: ca.(13–17.9–24) [*n*=16]. With each posterior spiracle: ca.(5–6.2–9) [18].

Perivulvar disc pores. In median group: 8–18. In each anterolateral group: 17–25. In each posterolateral group: 10–21. Total: 70–86.3–99 [*n*=9].

Dorsal macroducts. Submedian macroducts on abd III–VI, occasionally absent on VI, submedian rows divided into segmental and infrasegmental series on III and IV; submarginal macroducts on III–V. Submedian macroducts: 1–4 in each of segmental and infrasegmental series on III; 2, 3 and 1–3 on IV; 1–3 in segmental row on V; 0 [*n*=1], 1 [17] on VI. Submarginal macroducts: 2–5 on III; 2–4 on IV and V each. Total of dorsal macroducts: 32–44.9–55 [9].

Lateral macroducts. On abd II: 6–7.5–9 [*n*=17]. On III: 6–6.9–8 [18].

Lateral gland spines. On abd II: 3–6.3–9 [*n*=17]. On III: 4–7.6–10 [17].

Marginal gland spines. On abd IV: 2 [*n*=17].

Microducts. A small cluster of 5–6.3–9 [*n*=18] dorsal microducts on prosoma near prosomatic tubercle.

Recognition characters

Adult female at full growth with prosoma well swollen, much broader than postsoma, of which the prepygidial segments are nearly the same in width; pygidium little roundish marginally. Prosoma broadest at the level of prosomatic tubercles, broadly rounded on anterior margin; prosomatic tubercles prominent, rounded apically, and broadened basally. Anterior spiracles each with disc pores forming a small thick arciform group of moderate size; posterior spiracles each with much fewer disc pores arranged along a line bent twice to form a narrowly and transversely oblong space. Perivulvar disc pores moderately numerous. Submarginal dorsal boss on abd I and also on III. Dorsal macroducts occurring on abd III–V and usually also on VI submedially and on III–V submarginally; submedian rows divided into segmental and infrasegmental series on III and IV, a few to several macroducts in each of these series and submedian row on V and also in submarginal rows on III–V each, usually 1 submedian macroduct present on VI. Lateral macroducts moderately numerous on abd II and III. Lateral gland spines on abd II and III, much shortened, nearly as numerous as lateral macroducts. Marginal gland spines 2 on abd IV. Median trullae separated from each other by a good space basally, then divergent, serrate on diverging mesal margins, each trulla longer than wide; basally united together through a well-developed sclerite, which is shaped like an inverted V and produced anteriorly beyond bases of the trullae. Second and third trullae well represented, with lobules broad and slanting apically. Marginal macroducts of abd VII extending anteriorly much beyond basal zygosis of median trullae. Marginal sclerotized processes of abd IV and V low, the one associated with mesal marginal macroduct on V

(pore prominence) pointed apically, that on IV pointed or blunt.

Remarks

This species is very similar to *Aulacaspis tubercularis* Newstead and distinguished from the latter on account of the basal zygotic sclerite of the median trullae, which is well developed in the shape of an inverted V and produced anteriorly beyond the bases of the trullae. This state of zygosis is unique to this species in the *tubercularis* group. It should be added that the examined specimens of *A. connari* are all foliicolous, whereas the foliicolous form of *A. tubercularis* has non-zygotic median trullae.

Aulacaspis swintoniae, n.sp.
(Fig. 2)

Material examined

Collected in Malaya on *Swintonia* (Anacardiaceae). Bukit Cendana, Pulau Pinang [Penang Is.], on *Swintonia floribunda*, 16.XI.1991, Sample 1; Kota Tinggi, Johor, on *Swintonia schwenkii*, 20.VIII.1990, Sample 2. Females and males occurring on leaves, mainly on the lower surface. Thirty-two mounted specimens from Sample 1 and 30 from Sample 2 have been examined for the numbers of wax-secreting organs; holotype from Sample 1.

Wax-secreting organs

Spiracular disc pores. Associated with each anterior spiracle: 3–5.2–9 [*n*=64] <Sample 1>; 7–8.7–11 [58] <2>. With each posterior spiracle: 2–3.7–5 [64] <1>; 3–4.2–5 [60] <2>.

Perivulvar disc pores. In median group: 4–11 <Sample 1>; 4–8 <2>. In each anterolateral group: 7–13 <1>; 8–12 <2>. In each posterolateral group: 4–10 <1>; 6–9 <2>. Total: 32–43.2–51 [*n*=31] <1>; 39–44.8–49 [30] <2>.

Dorsal macroducts. Occurring on abd II–VI submedially and on III–V submarginally; submedian rows on II–IV divided into segmental and infrasegmental series.

<Sample 1>. Submedian macroducts: 1 [*n*=2], 2 [62] in segmental and 1 [4], 2 [60] in infrasegmental series on abd II; 1 [15], 2 [49] and 0 [1], 1 [21], 2 [42] on III; 0 [2], 1 [58], 2 [4] and 0 [5], 1 [59] on IV; 0 [1], 1 [63] in segmental row on V; 0 [1], 1 [63] on VI. Submarginal macroducts: 1 [6], 2 [54], 3 [4] on III; 1 [61], 2 [3] on IV; 1 [44], 2 [20] on V. Total of dorsal macroducts: 25–31.2–37 [32].

<Sample 2>. Submedian macroducts. 1 [*n*=14], 2 [46] in segmental and 1 [21], 2 [39] in infrasegmental series on II; 0 [1], 1 [46], 2 [13] and 0 [1], 1 [45], 2 [14] on III; 1 [56], 2 [4] and 0 [9], 1 [51] on IV; 0 [1], 1 [59] in segmental row on V; 1 [60] on VI. Submarginal macroducts: 1 [14], 2 [46] on III; 1 [52], 2 [8] on IV; 1 [15], 2 [45] on V. Total of dorsal macroducts: 25–28.8–34 [30].

Lateral macroducts. On abd II: 3–5.9–7 [*n*=63] <Sample 1>; 4–6.8–8 [56] <2>. On III: 4–5.4–7 [61] <1>; 4–5.6–7 [59] <2>.

Lateral gland spines. On abd II: 2–4.5–7 [*n*=56] <Sample 1>; 3–5.3–7 [50] <2>. On III: 3–5.7–7 [57] <1>; 4–6.1–8 [57] <2>.

Marginal gland spines. On abd IV: 1 [*n*=2], 2 [61] <Sample 1>; 0 [1], 1 [5], 2 [52] <2>.

Recognition characters

Adult female at full growth with prosoma well swollen and much broader than postsoma, metathorax and prepygidial abdominal segments nearly the same in width, pygidium nearly triangular in outline. Peribuccal scleroses well formed. Spiracular disc

pores few. Perivulvar disc pores in small groups. Marginal setae on metathorax and abd I, especially those on ventral surface, much elongated, attaining about 19–25μm on metathorax. Submarginal dorsal boss on abd I and also on III. Dorsal macroducts on abd II–VI submedially, except for rare absence on VI, and on III–V submarginally; submedian rows on II–IV divided into segmental and infrasegmental series; few in each of these series and also in submedian row on V and submarginal rows on III–V, usually 1 present on VI. Lateral macroducts on abd II and III, moderate in number. Lateral gland spines on abd II and III, small, as many as lateral macroducts. Marginal gland spines on pygidium also reduced in size, 2, rarely 1, on abd IV. Marginal macroducts elongate, those occurring on abd VII extending much beyond bases of median trullae. Median trullae non-zygotic, the basal scleroses small, converging anteriorly and extending into a pair of sclerotized lines of derm; elongate, separated from each other by a space basally, then divergent, serrate on diverging mesal margins, rounded apically. Lateral trullae well represented. Marginal processes on abd IV and V low, 1 or 2 small pointed processes near lateral marginal macroduct on IV.

Remarks

This species is similar to *A. tubercularis* but differs from the latter in having much elongated marginal setae on the metathorax and the first abdominal segment. Such marginal setae are also found in *Aulacaspis mischocarpi* (Cockerell and Robinson) and a few other species of the genus, but it does not seem that the present new species is particularly closely related to those species. The occurrence of one or two spinous processes on the margin of the fourth abdominal segment, opposite the lateral marginal macroduct, is also a noteworthy character of *A. swintoniae*. These processes may correspond to the 'spurs' in the *calcarata* species group (as to this group, see Takagi, 1999). However, the occurrence of elongated marginal setae on the metathorax and the first abdominal segment is strange also to the *calcarata* group as originally composed.

Aulacaspis nephelii Takagi, 2016
(Fig. 3, 4)

Material examined

Collected at Pantai Sungai Miang, Pekan, near Nenasi, Pahang, Malaya, on *Scurrula ferruginea* (Loranthaceae), 16.VII.1990. Females and males occurring on the lower surface of leaves, females also on twigs; almost buried under tomentum on these parts of the host plant. Eleven adult females, various in growth, were mounted from leaves, Subsample 1; 4 adult females, all at full growth, from twigs, Subsample 2.

Wax-secreting organs

Spiracular disc pores. Associated with each anterior spiracle: 8–13.1–17 [*n*=22] <Subsample 1>; 10–16 [7] <2>. With each posterior spiracle: 1–4.2–5 [22] <1>; 3–5 [8] <2> (usually 4 in each subsample).

Perivulvar disc pores. In median group: 9–14 <Subsample 1>; 7–14 <2>. In each anterolateral group: 16–29 <1>; 17–27 <2>. In each posterolateral group: 8–18 <1>; 8–16 <2>. Total: 74–91.0–103 [*n*=10] <1>; 58–93 [4] <2>.

Dorsal macroducts. Occurring on abd III–V submedially and submarginally. Submedian rows distinctly divided into segmental and infrasegmental series on abd III and IV.

<Subsample 1>. Submedian macroducts: 1–3 in segmental and 0 [*n*=2], 1–3 [20] in infrasegmental series on abd III; 1–3 and 0 [7], 1 [4], 2 [11] on IV; 1–3 in segmental row on V. Submarginal macroducts: 3–5, 1–4, and 1–5 on III, IV, and V, respectively. Total of dorsal macroducts: 21–34.6–47 [11].

<Subsample 2>. Submedian macroducts: 1–4 in segmental and 0 [*n*=1], 1–3 [7] in infrasegmental series on abd III; 1–3 and 0 [4], 2 [4] on IV; 1–3 in segmental row on V. Submarginal macroducts: 1–4 on III and IV each; 1–3 on V. Total of dorsal macroducts: 13, 34 [2], 40.

Lateral macroducts. On abd II: 3–5.3–7 [*n*=19] <Subsample 1>; 3–6 [8] <2>. On III: 5–5.5–7 [19] <1>; 3–7 [8] <2>.

Lateral gland spines. On abd II: 4–5.1–8 [*n*=19] <Subsample 1>; 3–7 [8] <2>. On III: 5–7.2–10 [19] <1>; 3–8 [8] <2>.

Marginal gland spines. On abd IV: 2 [*n*=22] <Subsample 1>; 2 [8] <2>.

Recognition characters

Adult female at full growth robust, cuneiform, with prosoma broadest, and with metathorax, abd I, and abd II gradually narrower and pygidium little roundish marginally. Prosoma remarkably enlarged, attaining about 1.5 times as broad as long, nearly quadrate to broadly roundish; prosomatic tubercles distinctly produced and broadly rounded; peribuccal scleroses not formed. Anterior spiracles each with a small cluster of disc pores; posterior spiracles each with a few to several disc pores arranged transversely. Perivulvar disc pores moderate in number, antero- and posterolateral groups slender, 2- or 3-pores wide. Submarginal dorsal boss on abd I and also on III. Dorsal macroducts on abd III–V submedially and submarginally; submedian rows divided into segmental and infrasegmental series on III and IV; few in each of these series and also in segmental row on V, occasionally none in infrasegmental series; submarginal rows each with a few to several macroducts. Lateral macroducts and lateral gland spines moderate in number on abd II and III. Marginal gland spines 2 on abd IV. Marginal macroducts on abd IV and V about 1.5–2 times as long as orifice, those on VII usually hardly extending anteriorly beyond basal zygosis of median trullae. Median trullae zygotic basally, robust, variable in breadth, separated from each other by a good space basally, then divergent to blunt or rounded apices, minutely serrate on mesal margins, which are nearly straight or roundish; basal zygosis also variable in development, usually strongly developed, horseshoe-shaped, produced anteriorly distinctly beyond the bases of the trullae, and broadly roundish on anterior margin, at times reduced in size and shape, even into a pair of small sclerites. Second and third trullae well represented. Marginal processes on abd IV and V low, those associated with mesal marginal macroducts on these segments (pore prominences) usually a little produced and sharply pointed.

Remarks

Aulacaspis nephelii was described on the basis of a sample collected on *Nephelium maingayi* (Sapindaceae) in Malaya and, at that time, a single specimen from *Helixanthera* sp. (Loranthaceae) and from another locality in Malaya was referred to the species (Takagi, 2016). The sample examined in the present study was collected on *Scurrula ferruginea*, another loranthaceous plant. It is identified with the species, but with some reservation. The description above is based exclusively on this sample.

The specimens from *Scurrula* do not exactly agree with the type series from

Nephelium and *Helixanthera* in having the median trullae broader and the basal zygosis of the trullae usually strongly developed. However, they are considerably variable in the breadth of the median trullae, approaching to the type series at one extreme of the variation, and are variable in the development of the basal zygosis so broadly as to overlap with the type series (Fig. 4; compare with Takagi, 2016, fig. 11). There have been found no distinct differences in other features between the specimens from *Scurrula* and those from *Nephelium* and *Helixanthera*.

The specimens of the type series were collected from the glabrous leaves of the host plants, whereas those occurring on *Scurrula ferruginea* were found under the tomentum of the plant body. The view may be adopted that, in the specimens occurring on *Scurrula*, the tendency to have robust median trullae and a strong basal zygosis is associated with the burrowing behaviour. It is not knowable whether they represent a genetically differentiated form adapted to the host plant or a case of host plant effect on phenotype, because unstable phenotypic characters may be involved in either case. In the present state of my study, however, there seems to be no good reason to recognize the *Scurrula*-associated form as a distinct species.

Aulacaspis nephelii as understood in the present study is referable to the *tubercularis* species group, because it may be related to *Aulacaspis scurrulae* Takagi, which also burrows under the leaf tomentum on *Scurrula ferruginea* and was described as a member of the group. It differs from *A. scurrulae* in the body shape of the adult female, being robust and cuneiform at full growth, and also in the median trullae, which are less roundish on the diverging mesal margins even when they are much thickened. In other respects, these two species are considerably similar.

The inclusion of *A. connari*, *A. swintoniae*, and *A. nephelii* in the *tubercularis* species group may broaden the group to accept still more species, making it obscurely bordered. However, this may be natural for the reason mentioned in the introduction under the subtitle. It follows that some or many morphological species groups formed or to be formed in *Aulacaspis* may be no more than assemblages of species made for convenience of study.

Two species with enlarged microducts

Among the wax-secreting organs, those currently called ‘microducts’ have received little attention in diaspidid taxonomy except when they occur in some situations, for example, when they are associated with macroducts or replace the latter. This neglect is apparently due to their minuteness. Their occurring patterns on the body, however, may be useful in recognizing species in some cases.

One of the two species described in this section is provided with microducts of a distinct type on the dorsal surface of the prosoma and basal two postsomatic segments, and the other has similar microducts on the ventral surface of the prosoma. These microducts are differentiated in size, being apparently larger than other microducts found nearby or on the opposite surface, and crowded together or strewn on specified body parts. They are called ‘enlarged microducts’ in this paper. In *Aulacaspis*, the occurrence of enlarged microducts is not limited to these species and its taxonomic value is not always clear as will be shown under *Remarks* for *Aulacaspis buteae*. Above all, we are ignorant of the rôle of these unusual microducts in adaptation.

Aulacaspis buteae Takahashi, 1942
(Fig. 5, 6)

Material examined

Collected at Godavari, Mt. Phulchoki, alt. ca.1600m, Kathmandu Valley, Nepal, 21.VIII.1975. On collecting the material I supposed that the host plant was a species of *Lespedeza* (Fabaceae) but, later, I failed to confirm my supposition for a certain reason. Females and males occurring on branches. Mounted specimens include 19 full-grown adult females, Subsample 1, and 9 growing adult females, Subsample 2. The specimens of Subsample 1 are generally so poor in condition as to suggest that the insects were collected after their death. Subsample 2, therefore, should represent the generation next to Subsample 1.

Wax-secreting organs

Spiracular disc pores. Associated with each anterior spiracle: 10–16.2–23 [*n*=32] <Subsample 1>; 10–16.1–24 [17] <2>. With each posterior spiracle: 8–10.2–18 [28] <1>; 7–10.0–15 [17] <2>.

Perivulvar disc pores. In median group: 15–25 <Subsample 1>; 15–29 <2>. In each anterolateral group: 15–41 <1>; 28–42 <2>. In each posterolateral group: 19–39 <1>; 26–38 <2>. Total: 115–143.1–181 [*n*=19] <1>; 128–150.8–172 [9] <2>.

Dorsal macroducts. Occurring on abd III–V or –VI submedially and on III–V submarginally; submedian rows on III–V divided into segmental and infrasegmental series.

<Subsample 1>. Submedian macroducts: 1 [*n*=1], 2 [2], 3 [14], 4 [21] in segmental and 2 [2], 3 [11], 4 [25] in infrasegmental series on abd III; 2 [20], 3 [14], 4 [3], 5 [1] and 0 [5], 1 [1], 2 [22], 3 [10] on IV; 1 [4], 2 [19], 3 [12], 4 [3] and 0 [22], 1 [5], 2 [11] on V; 0 [11], 1 [27] on VI. Submarginal macroducts: 2 [1], 3 [1], 4 [6], 5 [15], 6 [9], 7 [4], 8 [1] on abd III; 0 [1], 2 [3], 3 [26], 4 [6], 5 [1], 6 [1] on IV; 2 [15], 3 [14], 4 [6], 5 [1], 6 [2] on V. Total of dorsal macroducts: 45–56.2–94 [18].

<Subsample 2>. Submedian macroducts: 1 [*n*=1], 2 [1], 3 [4], 4 [12] in segmental and 2 [2], 3 [2], 4 [14] in infrasegmental series on abd III; 2 [7], 3 [5], 4 [3], 5 [2], 6 [1] and 0 [4], 1 [1], 2 [9], 3 [4] on IV; 0 [1], 2 [7], 3 [6], 4 [4] and 0 [13], 2 [5] on V; 0 [8], 1 [10] on VI. Submarginal macroducts: 0 [1], 3 [1], 4 [1], 5 [8], 6 [7] on abd III; 3 [12], 4 [5], 6 [1] on IV; 2 [7], 3 [9], 4 [2] on V. Total of dorsal macroducts: 44–53.9–60 [9].

Lateral macroducts. On abd II: 6–8.8–12 [*n*=33] <Subsample 1>; 8 [13], 9 [5] <2>. On III: 5–7.0–9 [31] <1>; 6 [1], 7 [14], 8 [2], 9 [1] <2>.

Lateral gland spines. On abd II: 5–6.3–8 [*n*=24] <Subsample 1>; 4 [1], 6 [2], 7 [7], 8 [3], 9 [1] <2>. On III: 7–8.5–10 [25] <1>; 6 [2], 7 [8], 8 [3], 9 [3], 10 [1] <2>.

Marginal gland spines. On abd IV: 1 [*n*=1], 2 [35] <Subsample 1>; 1 [1], 2 [17] <2>.

Enlarged microducts. Occurring dorsally, forming submarginal clusters on pro- and mesothoracic areas of prosoma and on metathorax and abd I. On prothoracic area: 4–9.0–23 [*n*=33] <Subsample 1>; 9–15.6–20 [14] <2>. On mesothoracic area: 2–6.1–14 [32] <1>; 5–10.6–15 [16] <2>. On metathorax: 4–7.4–17 [32] <1>; 6–11.1–14 [16] <2>. On abd I: 1–5.7–9 [32] <1>; 4–7.1–10 [16] <2>.

Recognition characters

Adult female at full growth with prosoma well swollen, distinctly broader than postsoma, nearly quadrate or enlarged into an almost rounded mass; metathorax and abd II about the same in width, abd I narrower; pygidium nearly triangular. Prosomatic tubercles each represented by a small protuberance at most. Anterior spiracles each

with a rather small loose cluster of pores; posterior spiracles each with some disc pores mostly arranged along a curved line, the lateralmost ones laid in a dermal fold. Enlarged dorsal microducts occurring submarginally on pro- and mesothoracic areas of prosoma, metathorax, and abd I, forming loose segmental clusters, the prothoracic cluster being distinctly separated from the mesothoracic one, the former situated opposite prosomatic tubercle and the latter in posterolateral corner of prosoma; each cluster broadly variable in size, sometimes with a few or several microducts only. Submedian dorsal boss on abd I and also on III. Dorsal macroducts occurring on abd III–V or –VI submedially and on III–V submarginally, submedian rows on III–V divided into segmental and infrasegmental series, a few to several macroducts occurring in each series, at times none in infrasegmental series on IV and V; 1 submedian macroduct present or absent on VI; a few to several macroducts in submarginal rows except for rare absence on III or IV. Lateral macroducts well represented in number on abd II and III. Lateral gland spines shortened, as many as lateral macroducts. Marginal gland spines usually 2, occasionally 1, on abd IV. Marginal macroducts of abd VII a little extending anteriorly beyond basal zygotic sclerite of median trullae. Median trullae with a distinct zygotic sclerite, which is rounded on anterior margin and deeply incised medially on posterior side; separated from each other by a good space basally, then divergent to rounded apices, finely serrate on diverging mesal margins. Lateral trullae well represented. Marginal processes on abd IV and V low.

Remarks

Aulacaspis buteae was described by Takahashi (1942) from Chiengmai, Thailand, and from *Butea frondosa* (Fabaceae). In the description he states: 'Gland spines 6 on each side' of pygidium. I have checked this sentence with his figure (fig. 20) and interpreted it to mean that two marginal gland spines occur on the fourth abdominal segment and one on each of the four succeeding segments (the fifth to eighth segments), thus six gland spines occurring on each side of the pygidium. So far as based on this interpretation, his statement that 'the 4th with … about 5 short gland spines' should mean that the third abdominal segment has about five short lateral gland spines. Accordingly, '2nd', '3rd', and '4th' segment in his description should be read as the first, second, and third abdominal segment, respectively. He may have counted the metathorax as the first segment, the first abdominal segment as the second, and so on. In reality, these segments are the first postsomatic segment (which is the metathorax), the second postsomatic segment (the first abdominal segment), and so on. He writes: 'Cephalothorax … with a loose group of minute gland ducts on the sublateral area …; a similar group also present at the posterior angle and on the side of metathorax; … the 2nd with a few small lateral ducts'. I adopt the view that these parts of his description mention the occurrence of enlarged microducts in clusters near the body margin ('on the sublateral area') on the prosoma ('Cephalothorax'; two areas including 'the posterior angle', which belongs to the mesothorax), the metathorax, and the first abdominal segment ('the 2nd'). The view is also adopted that these discrete segmental clusters of enlarged microducts should be dorsal, because in the genus in general such clusters of usual or enlarged microducts, when occurring, are situated on the dorsal surface.

No specimens from the type series of *A. buteae* have been available for my study. It seems that the specimens from Godavari agree to a considerable degree with the original description and figure of the species so far as the description is revised as stated

above. In the course of the present study, I have concluded that the specimens should belong to *A. buteae*, but with a few conditions. One of the conditions is that the enlarged microducts should really occur on the dorsal surface in the specimens from Chiengmai. The other conditions are concerned with the occurrence of lateral macroducts on the third abdominal segment ('the 4th') and also of disc pores in association with the posterior spiracles. There is no mention of these features in the original description.

Even if the specimens from Godavari really belong to *A. buteae*, there is another question. I (Takagi, 2013) examined a number of specimens of *Aulacaspis crawii* (Cockerell) collected in Hong Kong, Malaya, Singapore, lowland Nepal (Terai), and Natal on various plants. The occurrence of enlarged dorsal microducts nearly in the same pattern as described above for the Godavari specimens was observed in *A. crawii*, but only in one of four samples collected in lowland Nepal and in the ramicolous specimens, not in the foliicolous ones at all, of that sample. Through all the specimens of *A. crawii* I examined, it was no more than a character that was observed in a feeding-site subsample of a local sample, and thus it was aberrant rather than normal for the species. So far as generalized from these observations, the emergence of this character in *A. crawii* should take place only occasionally and abruptly in a limited part of the species population, so that it may be interpreted to be atavistic.

The Godavari form referred to *A. buteae* is known only from the ramicolous specimens. Takahashi makes no mention of the feeding site or sites of his specimens on *Butea frondosa*. It remains uncertain, therefore, whether the occurrence of enlarged microducts is a stable character in *A. buteae*. Further samples having foliicolous and ramicolous specimens may be necessary for clarifying this question and the taxonomic significance of the character in this species.

If the occurrence of enlarged microducts on the dorsal surface of the prosoma and the basal two segments of the postsoma is stable and constant in *A. buteae*, this character is helpful in recognizing the species. In other respects, the species is an ordinary *Aulacaspis* form. Takahashi mentioned *Aulacaspis rosae* (Bouché) as a relative of *A. buteae*. When the enlarged microducts are disregarded, *A. buteae* indeed appears to be similar to *A. rosae*, from which it may be distinguished in the body apparently constricted across the first abdominal segment, in the sixth abdominal segment having on each side only one submedian macroduct or none, and in the lateral gland spines much shortened.

Aulacaspis connarorum, n.sp.
(Fig. 7, 8)

Material examined

Collected in Malaya, along the eastern coast of the peninsula, on *Fissistigma* (Annonaceae) and *Connarus* (Connaraceae).

Bukit Bauk, Terengganu, on *Fissistigma lanuginosum*, 15.VII.1990, Sample 1. Thirty-one adult females have been examined.

Cape Gelang, Kuantan, Pahang, on *Connarus ferrugineus*, 9.VII.1990, Sample 2. Mounted specimens include 32 adult females examined in the present study.

Beserah Forest Reserve, Kuantan, Pahang, on *Connarus ferrugineus*, 26.VII.1990, Sample 3. Twenty-one adult females.

Desaru, Johor, on *Connarus paniculatus*, 21.VIII.1990, Sample 4. Six adult females.

Females and males occurring on leaves, mainly on the lower surface; in Sample 4, females feeding also on twigs, and six ramicolous specimens have been examined. Holotype, from Sample 3.

Wax-secreting organs

Spiracular disc pores. Associated with each anterior spiracle: 7–11.6–16 [*n*=61] <Sample 1>; 5–12.2–19 [61] <2>; 9–15.2–21 [42] <3>; 10–12.6–16 [12] <4>. With each posterior spiracle: 1–3.3–5 [61] <1>; 2–3.8–6 [64] <2>; 2–3.5–5 [41] <3>; 3–3.6–5 [12] <4>.

Perivulvar disc pores. In median group: 4–12 <Sample 1>; 6–11 <2>; 8–12 <3>; 7–11 <4>. In each anterolateral group: 9–19 <1>; 7–19 <2>; 11–19 <3>; 12–18 <4>. In each posterolateral group: 5–15 <1>; 7–14 <2>; 8–16 <3>; 6–12 <4>. Total: 41–53.4–76 [*n*=31] <1>; 44–55.4–71 [32] <2>; 55–63.8–78 [21] <3>; 46–61 [5] <4>.

Dorsal macroducts. Submedian macroducts occurring on abd II–V and frequently also on I and VI, rows on I–IV divided into segmental and infrasegmental series; submarginal macroducts occurring on III–V, and occasionally on II and rarely on I, very rarely infrasegmental series present on I and II.

<Sample 1>. Submedian macroducts: 0 [*n*=17], 1 [21], 2 [16], 3 [4], 4 [1] in segmental and 0 [25], 1 [18], 2 [14], 3 [1], 4 [1] in infrasegmental series on abd I; 0 [2], 1 [24], 2 [21], 3 [6], 4 [6] and 0 [9], 1 [14], 2 [27], 3 [6], 4 [3] on II; 0 [2], 1 [19] , 2 [34], 3 [4] and 0 [19], 1 [9], 2 [27], 3 [4] on III; 1 [23], 2 [29], 3 [4], 4 [3] and 0 [53], 1 [2], 2 [4] on IV; 1 [37], 2 [21], 3 [1] and 0 [60] on V; 0 [49], 1 [11] on VI. Submarginal macroducts: 0 [62] in segmental and 0 [62] in infrasegmental series on abd I; 0 [52], 1 [8], 2 [2] and 0 [62] on II; 0 [2], 1 [19], 2 [29], 3 [11], 4 [1] on III; 1 [25], 2 [30], 3 [7] on IV; 1 [14], 2 [43], 3 [5] on V. Total of dorsal macroducts: 12–35.6–69 [29].

<Sample 2>. Submedian macroducts: 0 [*n*=33], 1 [19], 2 [10], 3 [2] in segmental and 0 [27], 1 [21], 2 [15], 3 [1] in infrasegmental series on abd I; 1 [21], 2 [26], 3 [16], 4 [1] and 0 [3], 1 [19], 2 [30], 3 [7], 4 [5] on II; 1 [27], 2 [25], 3 [11], 4 [1] and 0 [11], 1 [17], 2 [29], 3 [5], 4 [2] on III; 0 [4], 1 [27], 2 [29], 3 [1], 4 [3] and 0 [46], 1 [9], 2 [9] on IV; 0 [1], 1 [28], 2 [33], 3 [2] and 0 [63], 1 [1] on V; 0 [27], 1 [37] on VI. Submarginal macroducts: 0 [64] in segmental and 0 [64] in infrasegmental series on I; 0 [55], 1 [9] and 0 [64] on II; 1 [13], 2 [30], 3 [20], 4 [1] on III; 1 [10], 2 [47], 3 [7] on IV; 1 [7], 2 [47], 3 [10] on V. Total of dorsal macroducts: 18–38.2–65 [32].

<Sample 3>. Submedian macroducts: 0 [*n*=5], 1 [9], 2 [14], 3 [11], 4 [3] in segmental and 0 [5], 1 [14], 2 [11], 3 [8], 4 [4] in infrasegmental series on abd I; 2 [24], 3 [10], 4 [7], 5 [1] and 0 [2], 1 [4], 2 [17], 3 [8], 4 [11] on II; 1 [5], 2 [24], 3 [11], 4 [2] and 0 [1], 1 [3], 2 [26], 3 [5], 4 [7] on III; 1 [5], 2 [24], 3 [10], 4 [3] and 0 [23], 1 [4], 2 [15] on IV; 1 [3], 2 [33], 3 [6] and 0 [41], 1 [1] on V; 0 [19], 1 [22], 2 [1] on VI. Submarginal macroducts: 0 [40], 1 [2] in segmental and 0 [41], 1 [1] in infrasegmental series on I; 0 [19], 1 [10], 2 [10], 3 [3] and 0 [40], 1 [2] on II; 2 [12], 3 [18], 4 [9], 5 [3] on III; 2 [24], 3 [12], 4 [6] on IV; 0 [1], 2 [23], 3 [16], 4 [2] on V. Total of dorsal macroducts: 34–55.8–88 [21].

<Sample 4>. Submedian macroducts: 0 [*n*=3], 1–4 [9] in segmental and 0 [5], 1–3 [7] in infrasegmental series on I; 0 [2], 1–5 [10] and 0 [2], 2–4 [10] on II; 1–3 [12] and 0 [2], 1–3 [10] on III; 1–4 [12] and 0 [10], 2 [2] on IV; 1 [5], 2 [7] and 0 [12] on V; 0 [2], 1 [9], 2 [1] on VI. Submarginal macroducts: 0 [12] in segmental and 0 [12] in infrasegmental series on I; 0 [9], 1 [2], 2 [1] and 0 [12] on II; 1–4 [12] on III; 1–3 [12] on IV; 1–3 [12] on V. Total of dorsal macroducts: 14–65 [6].

Lateral macroducts. On abd II: 3–4.8–6 [*n*=61] <Sample 1>; 4–4.9–7 [59] <2>; 4–5.6–7 [41] <3>; 3–4.8–6 [12] <4>. On III: 3–4.1–6 [62] <1>; 3–4.5–6 [62] <2>; 3–4.8–6 [41] <3>; 3–4.4–5 [12] <4>.

Lateral gland spines. On abd II: 1–3.0–5 [*n*=61] <Sample 1>; 1–3.6–7 [58] <2>; 2–4.0–6 [41] <3>; 2–3.5–6 [12] <4>. On III: 3–5.1–7 [62] <1>; 3–5.8–9 [63] <2>; 4–6.6–9 [41] <3>; 5–6.0–7 [12] <4>.

Marginal gland spines. On abd IV: 1 [n=25], 2 [37] <Sample 1>; 1 [8], 2 [51], 3 [4] <2>; 1 [3], 2 [34], 3 [5] <3>; 2 [12] <4>.

Enlarged microducts. Strewn ventrally on pro- and mesothoracic areas of prosoma, forming segmental groups, which are not always clearly distinguishable from each other. Counted all together for each side of prosoma: 14–21.8–29 [*n*=60] <Sample 1>; 13–21.1–30 [63] <2>; 17–27.1–38 [40] <3>; 20–24.5–27 [11] <4>. Usually present also on basal two postsomatic segments, but too few to form clusters.

Recognition characters

Adult female at full growth with prosoma distinctly broader than postsoma, metathorax and basal 2 abdominal segments nearly the same in width, pygidium nearly straight marginally. Prosoma with anterior margin rounded and with lateral sides nearly parallel to each other; prosomatic tubercles large, broadly rounded; peribuccal scleroses well formed. Anterior spiracles each with a small cluster of disc pores; posterior spiracles each with a few to several disc pores. Perivulvar disc pores in small groups. Enlarged microducts strewn submarginally on ventral surface of prosoma in pro- and mesothoracic areas, especially extensively on mesothorax; usually present also on metathorax and first abdominal segment ventrally within lateral margin, but generally few. A small but distinct dorsal boss at times discernible on abd III near marginal macroduct. Dorsal macroducts, when in a complete set, occurring on abd I–VI submedially and on I–V submarginally, submedian rows on I–V and submarginal rows on I and II being divided into segmental and infrasegmental series; seldom fully occurring in all these rows and series, submedian macroducts irregularly lacking and submarginal ones usually absent from I and II; few in number in each row or series whenever present; abd VI with 1 or rarely 2 submedian macroducts or often with none. Lateral macroducts and lateral gland spines well represented on abd II and III. Marginal gland spines 1–3 on abd VI. Marginal macroducts short, nearly as long as or a little longer than orifice. Median trullae large, deeply sunken, making a large notch at apex of pygidium, united basally through a thick zygotic sclerite, which is rounded on anterior margin; elongate, tapering apically; separated from each other by a space subbasally, then strongly divergent to narrow blunt apices, the diverging mesal margins nearly straight or slightly roundish, finely serrate. Second and third trullae well developed, each lobule elongate and spatulate. Marginal processes of abd IV and V low, minutely serrate.

Remarks

Three foliicolous samples from three localities and one ramicolous sample from another locality have been examined in the present study. They agree in having enlarged microducts strewn on the ventral surface of the prosoma. It is very probable that this character is stable in this species and is adoptable in recognizing the species (in this connection, see under *Remarks* for *Aulacaspis buteae*).

This species is also characteristic in the median trullae, which are large, strongly divergent, and tapering apically. In this feature, it is somewhat similar to *Aulacaspis actinodaphnes* Takagi (for newly prepared figures, see Takagi, 2014, fig. 9, 10T). These two species may have no particular relation between them, differing greatly in other

features. It seems that *A. connarorum* has no particular relation to *A. connari*, which is described from Luzón under the first subtitle in this paper.

Provided the host record of Sample 1 is correct, this species occurs on plants of at least two genera belonging to remotely related families. There has been found no serious differences in the adult females between the sample from *Fissistigma* and the three samples from *Connarus*.

Two species associated with Bauhinia in Borneo

The two species described in this section are represented by three samples collected from plants of *Bauhinia* and from two localities in northern Borneo, which are widely separated from each other and should be considerably different in environmental conditions. These species are closely similar to each other, but in a certain feature they are clearly distinguishable and therefore they are described as different species. These species are, however, variable in some other features, and in the variation of the median trullae they form an almost continuous series. All this, combined with the supposable occurrence of variation on the feature adopted for distinguishing the species, suggests another interpretation for the taxonomic relation between the two species.

Aulacaspis bauhiniae, n.sp.
(Fig. 9, 11G, I)

Material examined

Collected in the Kinabalu National Park, alt. ca.1500m, Sabah, Borneo, on *Bauhinia* sp. (Fabaceae), 7.X.1988. Females and males occurring on leaves, mainly on the lower surface and along veins, and most of the females on the basal part of the leaf blade; female test thin. Twelve mounted females, including the holotype.

Wax-secreting organs

Spiracular disc pores. Associated with each anterior spiracle: 5–10.3–23 [*n*=24]. With each posterior spiracle: 3–4.0–6 [24].

Perivulvar disc pores. In median group: 8–16. In each anterolateral group: 10–20. In each posterolateral group: 7–15. Total: 52–64.9–76 [*n*=12].

Dorsal macroducts. Occurring usually on abd IV and V and at times also on III submedially and on III–V submarginally; at times lacking submedially and on III and IV submarginally; submedian row on V usually divided into segmental and infrasegmental series. Submedian macroducts: 0 [*n*=22], 1 [2] on abd III; 0 [6], 1 [10], 2 [8] on IV; 0 [3], 1 [20], 2 [1] in segmental and 0 [8], 1 [15], 2 [1] in infrasegmental series on V. Submarginal macroducts: 0 [2], 1 [7], 2 [14], 4 [1] on III; 0 [3], 1 [15], 2 [6] on IV; 1 [18], 2 [6] on V. Total of dorsal macroducts: 2–13.6–20 [12].

Lateral macroducts. On abd II: 2–3.0–6 [*n*=21]. On III: 2–4.4–6 [23].

Lateral gland spines. On abd II: 0 [*n*=4], 1 [8], 2 [4], 3 [3]. On III: 1 [1], 3 [1], 5 [4], 6 [6], 7 [7], 8 [3].

Marginal gland spines. On abd IV: 1 [2], 2 [19], 3 [1].

Recognition characters

Adult female at full growth with prosoma swollen, distinctly but not much broader than postsoma, basal 3 postsomatic segments nearly the same in width, pygidium little

roundish marginally. Prosoma nearly half-circular to roughly quadrate; prosomatic tubercles not discernible; peribuccal scleroses not formed. Anterior spiracles each with a small group of disc pores; posterior spiracles each with several disc pores just laterally. Perivulvar disc pores in small groups. Submarginal dorsal boss on abd I, III, and V each. Dorsal macroducts usually present on abd IV and V submedially and on III–V submarginally, rarely also on III submedially, few, at times lacking submedially and on III and IV submarginally. Lateral macroducts few to several on abd II and III each. Lateral gland spines few and at times absent on abd II, 1–8 on III. Marginal gland spines 1–3, usually 2, on abd IV. Marginal macroducts short or tending to be so on abd III–V, those occurring just laterally to median trullae not extending anteriorly beyond bases of these trullae. Median trullae sunken into apex of pygidium, zygotic basally through a small but distinct sclerite; elongate, divergent from the bases to blunt apices, nearly straight or a little roundish and finely serrate on mesal margins. Marginal processes low on abd IV and V, processes associated with mesal marginal macroducts blunt.

Remarks

See *Remarks* under *A. phanerae*.

Aulacaspis phanerae, n.sp.
(Fig. 10, 11A–F, H)

Material examined

Collected in the Bako National Park, Muara Tebas Peninsula, Sarawak, Borneo, on plants of *Bauhinia* (Fabaceae): on *Bauhinia* sp., 9.X.1991, Sample 1; on *Bauhinia excelsa* (=*Phanera excelsa*), 10.X.1991, Sample 2. Females and males occurring on leaves; in Sample 1, females on leaf blades, Subsample 1, and on petioles, Subsample 2; 32 adult females mounted from Sample 1•Subsample 1, 4 from Sample 1•Subsample 2, and 32 from Sample 2 have been examined for the numbers of wax-secreting organs; holotype, from Sample 2.

Wax-secreting organs

Spiracular disc pores. Associated with each anterior spiracle: 3–5.1–8 [*n*=61] <Sample 1•Subsample 1>; 6–9 [7] <1•2>; 3–5.1–8 [58] <2>. With each posterior spiracle: 1–2.1–4 [63] <1•1>; 2–4 [8] <1•2>; 1–2.4–5 [62] <2>.

Perivulvar disc pores. In median group: 4–8 <Sample 1•Subsample 1>; 7, 8 <1•2>; 5–8 <2>. In each anterolateral group: 7–12 <1•1>; 9–12 <1•2>; 8–12 <2>. In each posterolateral group: 4–10 <1•1>; 6–11 <1•2>; 5–9 <2>. Total: 29–38.9–46 [*n*=32] <1•1>; 42–49 [4] <1•2>; 37–43.3–49 [32] <2>.

Dorsal macroducts. Present or absent on abd IV and V submedially and on III–V submarginally.

<Sample 1•Subsample 1>. Submedian macroducts: 0 [*n*=64] on abd IV; 0 [56], 1 [8] on V. Submarginal macroducts: 0 [61], 1 [3] on III; 0 [5], 1 [58], 2 [1] on IV; 0 [3], 1 [61] on V. Total of dorsal macroducts: 3–4.1–6 [32].

<Sample 1•Subsample 2>. Submedian macroducts: 0 [*n*=1], 1 [7] on abd IV; 1[8] on V. Submarginal macroducts: 0 [6], 1 [2] on III; 0 [1], 1 [7] on IV; 1 [8] on V. Total of dorsal macroducts: 8 [4].

<Sample 2>. Submedian macroducts: 0 [*n*=34], 1 [28], 2 [2] on abd IV; 0 [26], 1 [38] on V. Submarginal macroducts: 0 [38], 1 [26] on III; 0 [4], 1 [52], 2 [8] on IV; 0 [1], 1 [63] on V. Total of

dorsal macroducts: 3–7.1–12 [32].

Lateral macroducts. On abd II: 0 [*n*=6], 1 [45], 2 [8] <Sample 1•Subsample 1>; 1 [3], 2 [4] <1•2>; 0 [4], 1 [39], 2 [21] <2>. On III: 0 [1], 2 [12], 3 [45], 4 [3] <1•1>; 2 [1], 3 [7] <1•2>; 0 [1], 2 [6], 3 [57] <2>.

Lateral gland spines. On abd II: 0 [*n*=35], 1[22], 3 [1] <Sample 1•Subsample 1>; 0 [7] <1•2>; 0 [32], 1 [31], 2 [1] <2>. On III: 2 [2], 3 [29], 4 [28], 5 [2] <1•1>; 2 [1], 3 [5], 4 [2] <1•2>; 3 [14], 4 [33], 5 [17] <2>.

Marginal gland spines. On abd IV: 2 [*n*=63] <Sample 1•Subsample 1>; 2 [5], 3 [1] <1•2>; 2 [60], 3 [4] <2>.

Recognition characters

Adult female at full growth with prosoma swollen, distinctly but not much broader than postsoma, basal 3 postsomatic segments nearly the same in width, pygidium broad triangular in outline. Prosoma roughly quadrate in outline, broadly rounded on anterior margin, a little rounded laterally; prosomatic tubercles each represented by a small rounded prominence at most; peribuccal scleroses not formed. Anterior spiracles each with a very small group of disc pores; posterior spiracles each with a few to several disc pores just laterally. Perivulvar disc pores in small groups. Submarginal dorsal boss on abd I, III, and V each. Dorsal macroducts on abd IV and V submedially and submarginally, usually 1 on each segment when present, absent often submedially and at times submarginally; at times 1 submarginal macroduct present on III. Lateral macroducts few on abd II and III each, at times absent. Lateral gland spines few on abd II and III each, at most 5 on III, at times absent. Marginal gland spines 2 or at times 3 on abd IV. Marginal macroducts on abd III–V short; those occurring just laterally to median trullae not extending anteriorly beyond bases of median trullae. Median trullae sunken into apex of pygidium, united together basally, moderately divergent, variable in size and especially in breadth, oblong or broadened in various degrees, minutely serrate on mesal margins. Second and third trullae well represented. Marginal processes associated with mesal marginal macroducts on abd IV and V (pore prominences) produced, triangular, sharply pointed apically.

Remarks

Aulacaspis bauhiniae and *A. phanerae* are apparently closely related to each other. They are different in the numbers of the disc pores and macroducts, in the shape of the median trullae, and in the development of the pore prominences on the fourth and fifth abdominal segments.

The spiracular and perivulvar disc pores and also the dorsal and lateral macroducts are generally fewer in *A. phanerae*, and the differences are distinct in ranges or mean values. In both species, the dorsal macroducts are not only few in number but also unstable in occurrence on abdominal segments, and tend to be more unstable in *A. phanerae.*

The median trullae are little variable in shape in the examined specimens of *A. bauhiniae*, which are all from leaf blades. In the specimens of *A. phanerae* occurring on leaf blades, these trullae are variable in size and especially in shape: they are broadly expanded at one extreme of the variation, whereas at the other extreme they are much narrower, being similar to but not closely agreeing with the elongate median trullae of *A. bauhiniae*. The four specimens mounted from petioles have the median trullae broadest

among all the examined specimens. Thus, in this feature, *A. phanerae* approaches *A. bauhiniae* through its variation, but is still separated from the latter by a relatively small gap so far as observed in the available specimens (Fig. 11).

The pore prominences on the fourth and fifth abdominal segments are produced in the shape of a triangle and sharply pointed apically in *A. phanerae*, whereas the corresponding processes are low and tubercular in *A. bauhiniae*. These characters are stable in the examined samples, and therefore *A. bauhiniae* and *A. phanerae* are described as different species. However, it should be added here that in *Aulacaspis acuta* Takagi the corresponding marginal processes are variable in shape: usually they are produced and sharply pointed as in *A. phanerae*, but sometimes, sporadically among individuals, they are reduced into low angular processes (see Takagi, 2010, in which many samples of *A. acuta* were examined). The occurrence of variation in a similar pattern on the pore prominences in *A. phanerae* may not be unsupposable.

The collection localities of the two species, Mt. Kinabalu and the Muara Tebas Peninsula, are more than 800km distant from each other. These montane and maritime localities should be considerably different in environmental conditions. In consideration of the geographical distance, the habitats, the observed patterns of morphological variation, and the supposable occurrence of variation on the pore prominences of the fourth and fifth abdominal segments (extrapolated from *A. acuta*), the possibility may not be excluded that the available samples of *A. bauhiniae* and *A. phanerae* belong to a large variable population distributed across the island, thus representing extreme local forms of one and the same species.

Two species with allopatric forms

In the section above, two apparently closely related but distinct allopatric forms are shown to be connectable with each other by means of varying features and a supposedly variable feature. In general, closely related allopatric populations of native organisms at times produce taxonomic problems which are not easily clearable. Such populations should have long been under the ecological conditions of their habitats, and their morphological features may reflect their adaptation to those conditions.

Aulacaspis robusta has been known from Taiwan alone. In the present study, it is recorded from Borneo, while no samples of the species have been available from areas intermediate between these islands. *Aulacaspis projecta*, which was described from Japan originally and redescribed at least twice from southern continental China, is recorded from Taiwan in this paper. It seems that it is native to a broad region in eastern Asia in association with some diverse plants.

Aulacaspis robusta Takahashi, 1931
(Fig. 12–16)

Material examined

Collected on plants of *Ardisia* (Myrsinaceae) in Taiwan and Borneo. Kuantzuling, Taiwan, on *Ardisia sieboldii*, 7.IV.1965, Sample 1; Mt. Serapi, Sarawak, Borneo, on *Ardisia* sp., 3.X.1991, Sample 2. Females occurring on branches; Sample 2 from under fungal mat (probably of *Septobasidium*). Thirty-two adult females from Sample 1 and 30 from Sample 2 have been examined for the numbers of wax-secreting organs.

Wax-secreting organs

Spiracular disc pores. Associated with each anterior spiracle: ca.(38–88) <Sample 1>; ca.(30–53) <2>. With each posterior spiracle: 11–18.4–36 [*n*=64] <1>; 5–11.0–19 [49] <2>.

Perivulvar disc pores. In median group: 30–57 <Sample 1>; 16–37 <2>. In each anterolateral group: 40–79 <1>; 34–61 <2>. In each posterolateral group: 32–58 <1>; 32–54 <2>. Total: 188–249.5–297 [*n*=32] <1>; 169–216.6–251 [30] <2>.

Dorsal macroducts. Occurring on abd III–V and often also on VI submedially and on III–V submarginally; submedian rows divided into segmental and infrasegmental series on III and IV, usually represented by segmental series alone on V.

<Sample 1>. Submedian macroducts: 1 [*n*=1], 2 [10], 3 [27], 4 [18], 5 [6], 6 [2] in segmental and 0 [3], 1 [3], 2 [26], 3 [25], 4 [7] in infrasegmental series on abd III; 2 [27], 3 [19], 4 [14], 5 [3], 6 [1] and 0 [16], 1 [9], 2 [28], 3 [11] on IV; 0 [1], 2 [6], 3 [27], 4 [23], 5 [6], 7 [1] and 0 [57], 2 [6], 3 [1] on V; 0 [33], 1 [29], 2 [2] on VI. Submarginal macroducts: 2 [1], 3 [3], 4 [32], 5 [19], 6 [4], 7 [4], 8 [1] on III; 3 [5], 4 [15], 5 [17], 6 [18], 7 [9] on IV; 4 [3], 5 [1], 6 [8], 7 [11], 8 [40], 9 [1] on V. Total of dorsal macroducts: 50–63.3–85 [32].

<Sample 2>. Submedian macroducts: 0 [*n*=1], 2 [5], 3 [9], 4 [29], 5 [11], 6 [5] in segmental and 0 [3], 1 [1], 2 [12], 3 [30], 4 [14] in infrasegmental series on abd III; 1 [1], 2 [3], 3 [25], 4 [30], 6 [1] and 0 [2], 2 [42], 3 [15], 4 [1] on IV; 2 [1], 3 [3], 4 [28], 5 [22], 6 [6] and 0 [57], 1 [1], 2 [2] on V; 1 [50], 2 [9], 3 [1] on VI. Submarginal macroducts: 3 [4], 4 [7], 5 [16], 6 [23], 7 [9], 8 [1] on III; 0 [1], 2 [1], 3 [6], 4 [18], 5 [26], 6 [7], 7 [1] on IV; 4 [1], 5 [7], 6 [17] , 7 [12], 8 [23] on V. Total of dorsal macroducts: 54–70.1–84 [30].

Lateral macroducts. On abd II: 1–3.4–6 [n=63] <Sample 1>; 0 [1], 1 [3], 2 [36], 3 [13], 4 [5] <2>. On III: 2–4.3–7 [64] <1>; 2–4.0–6 [59] <2>.

Lateral gland spines. On abd II: 0 [*n*=2], 1 [19], 2 [33], 3 [9] <Sample 1>; 0 [16], 1 [28], 2 [13], 3 [1] <2>. On III: 8–10.8–14 [64] <1>; 4–6.8–10 [59] <2>.**.**

Marginal gland spines. On abd IV: 3–5.5–8 [*n*=61] <Sample 1>; 3–5.1–7 [58] <2>. On abd V–VIII, single in both sample. On abd VI and VII, usually with a short prong arising at dorsal base in Sample 1.

Recognition characters.

Adult female at full growth robust; prosoma distinctly broader than postsoma, broadest subbasally; prosomatic tubercles low and roundish; peribuccal scleroses well formed. Anterior spiracles each with a large group of disc pores; posterior spiracles each with disc pores in irregular clusters. Perivulvar disc pores numerous. Submarginal dorsal boss on abd I and also on III, rounded; a small one discernible or not just mesally to submarginal macroduct row of V. Submedian macroducts on abd III–V, usually in segmental and infrasegmental series on III and IV and in segmental series alone on V, 1 or a few present or absent on VI. Submarginal macroducts on abd III–V. Lateral macroducts occurring on abd II usually, and also on III, a few to several ones on each segment. Lateral gland spines usually few on abd II, broadly variable in number on III. Marginal gland spines 3–8 on abd IV, 1 on each of V–VIII; gland spine occurring on VI and also on VII with or without a short prong arising at dorsal base. Median trullae produced, appressed together, with mesal margins separated from each other by a slender space; robust, broadly rounded apically, with a few notches on each side, mesal bases produced into pygidium; basal zygosis elongate, about as long as the trullae. Second and third trullae well represented, lobules slanting on lateral margin. Marginal processes on

abd IV and V low.

Remarks

Aulacaspis robusta has been known from Taiwan, where it occurs on *Ardisia sieboldii* (=*Bladhia sieboldii*). In the present study, it is recorded from Borneo for the first time and from *Ardisia* sp. There are some differences in the numbers of wax-secreting organs between the samples from Taiwan and Borneo as is often the case between conspecific samples from distantly separated areas. There are other differences which may require careful consideration.

The two samples do not exactly agree in the body outlines of the adult females at full growth. In the Taiwan form, the prosoma is much broadened subbasally, about 1.5–1.7 times as wide as long and nearly half-circular in outline, the metathorax is also remarkably broadened, and the whole postsoma gradually narrows posteriorly. In the Borneo form, the prosoma is less broadened, about 1.3–1.4 times as wide as long and roughly quadrate in outline, the metathorax is not particularly broadened, and the prepygidial postsomatic segments are nearly the same in width.

In the sample from Taiwan, the marginal gland spines occurring on the sixth and seventh abdominal segments are provided very frequently with a short prong arising from the dorsal base. The prong is often appressed to the stem spine so closely that it is not always easily visible. However, most of these marginal gland spines examined in the present study (51/60, that is, 85%, on the sixth abdominal segment; 59/60 on the seventh) have been found or presumed to be pronged. In the sample from Borneo, none of the marginal gland spines have been confirmed to be pronged.

Needless to say, the body shape changes remarkably during the growth of the adult female in many species of *Aulacaspis*. The possibility may not be excluded that conspecific individuals growing under different environmental conditions will exhibit different body shapes at full growth. In the sample from Taiwan, at least some marginal gland spines (10/120, ca.8%) occurring on the sixth and seventh abdominal segments have been presumed to be non-pronged. It is possible, therefore, that the difference in these gland spines between the two samples is no more than a matter of frequency. Above all, the geographical distance separating the two samples should not be ignored in evaluating these differences and in interpreting the taxonomic relation between them.

The sample from Borneo is referred to *A. robusta* with emphasis on agreements with the sample from Taiwan in other features. The association with *Ardisia*, common to the samples, is another reason for the identification. It should be added here that Tao (1999) mentioned *Aegle marmelos* (Rutaceae) as another host plant of *A. robusta* in Taiwan without giving any data or information to support the record from this introduced plant.

Aulacaspis projecta Takagi, 1961
(Fig. 17–19)

Material examined

Collected at four localities in Japan, Sample 1–4, and at one locality in Taiwan, Sample 5.

Kurikara Pass, Toyama Pref./Isikawa Pref., on an unidentified tree, 23.VI.1955, Sample 1. Twelve ramicolous adult females: type series.

Tubata, Isikawa Pref., on *Styrax japonica* (Styracaceae), 8.X.1962, Sample 2. Two ramicolous adult females.

Utatu-yama, near the city of Kanazawa, Isikawa Pref., on *Cornus controversa* (Cornaceae), 6.X.1982, Sample 3. Six ramicolous adult females.

Okada, Idu-Ôsima, on *Cornus controversa*, 2.VIII.1964, M. Nagasawa, Sample 4. Eight adult females.

Mt. Taiping, Yilan County, on *Symplocos laurifolia* (Symplocaceae), 12.VIII.1986, W. J. Wu, Sample 5. Two ramicolous adult females.

Wax-secreting organs

Spiracular disc pores. Associated with each anterior spiracle: ca.(55–75) <Sample 1>; ca.(55–58) <2>; ca.(51–68) <3>; ca.(30–55) <4>; ca.(60–70) <5>. With each posterior spiracle: ca.(26–50) <1>; 20–25 <2>; 29–43 <3>; 15–22.0–28 [*n*=16] <4>; ca.(31–46) <5>.

Perivulvar disc pores. In median group: 24–55 <Sample 1>; 20, 25 <2>; 6–30 <3>; 12–27 <4>; 33, 48 <5>. In each anterolateral group: 28–58 <1>; 25–31 <2>; 18–39 <3>; 19–41 <4>; 43–50 <5>. In each posterolateral group: 28–59 <1>; 27–38 <2>; 30–52 <3>; 18–43 <4>; 55–66 <5>. Total: 151–225.7–295 [*n*=11] <1>; 130,156 <2>; 132–169.7–196 [6] <3>; 98–131.3–163 [8] <4>; 233, 278 <5>.

Dorsal macroducts. Submedian macroducts on abd II–VI, present or absent on I; rows divided into segmental and infrasegmental series on I–V. Submarginal macroducts on III–V, present or absent on II.

<Sample 1>. Submedian macroducts: 0 [*n*=16], 1–5 [8] in segmental and 0 [20], 1 [4] in infrasegmental series on abd I; 1–6 and 0 [2], 1–4 [22] on II; 1–7 and 0 [2],1–6 [21] on III; 2–9 and 0 [3], 2–6 [21] on IV; 2–9 and 0 [11], 2–4 [13] on V; 5–11 on VI. Submarginal macroducts: 0 [4], 1–7 [19] on II; 6–14 on III; 6–16 on IV; 6–14 on V. Total of dorsal macroducts: 88–139.8–166 [11].

<Sample 2>. Submedian macroducts: 0 [*n*=3], 1 [1] in segmental and also in infrasegmental series on abd I; 1–4 and 0 [2], 2, 3 on II; 1–3 and 1–4 on III; 3–5 and 0 [4] on IV and also on V; 3 [1], 4 [3] on VI. Submarginal macroducts: 0 [2], 2, 5 on II; 3–9 on III; 5–7 on IV; 6–8 on V. Total of dorsal macroducts: 60, 106.

<Sample 3>. Submedian macroducts: 0 [*n*=12] in segmental and also in infrasegmental series on abd I; 1–3 and 0 [5], 1–3 [7] on II; 2–4 and 0 [1], 2–4 [11] on III and also on IV; 2–4 and 0 [2], 1–3 [10] on V; 2–7 on VI. Submarginal macroducts: 0 [10], 1, 2 on II; 1–9 on III; 3–9 on IV; 6–11 on V. Total of dorsal macroducts: 75–95.0–105 [6].

<Sample 4>. Submedian macroducts: 0 [*n*=13], 1 [3] in segmental and 0 [15], 1 [1] in infrasegmental series on I; 0 [4], 1–4 [12] and 0 [6], 1–3 [10] on II; 1–4 and 0 [2], 1–5 [14] on III; 1–7 and 0 [3], 1–4 [13] on IV; 1–7 and 0 [7], 1–3 [9] on V; 3–6 on VI. Submarginal macroducts: 0 [9], 1–4 [7] on II; 2–8 on III; 4–8 on IV; 3–9 on V. Total of dorsal macroducts: 56–80.6–116 [8].

<Sample 5>. Submedian macroducts: 1–4 in segmental and 2–4 in infrasegmental series on abd I; 8–11 and 3–8 on II; 6–9 and 4–9 on III; 5–7 and 4–8 on IV; 3–5 and 5–7 on V; 10 [*n*=3], 11 [1] on VI. Submarginal macroducts: 7–10 on II, 12–15 on III, 11–15 on IV, 11–14 on V. Total of dorsal macroducts: 223, 225.

Lateral macroducts. On abd II: 0 <Sample 1–5>. On III: 0 [*n*=21], 1 [3] <Sample 1>; 0 <2–5>.

Lateral gland spines. On abd II: 0 <Sample 1–5>. On III: 2–5.0–7 [*n*=23] <1>; 2–7 <2>; 3–5.3–7 [11] <3>; 3–5.9–8 [16] <4>; 14–18 <5>.

Marginal gland spines. On abd IV: 3–7.0–9 [*n*=23] <Sample 1>; 3–6 <2>; 3–4.8–6 [12] <3>; 1–4.3–6 [16] <4>; 10–13 <5>. On V: 3–4.8–7 [24] <1>; 2 [1], 3 [3] <2>; 2–3.6–5 [12] <3>; 2–2.4–4 [16] <4>; 3 [1], 4 [3] <5>. On VI: 1–2.9–5 [24] <1>; 1 [1], 2 [3] <2>; 1–2.2–4 [12] <3>; 1 [3], 2 [12] <4>; 2 [3], 3 [1] <5>. On VII: not always exactly observed, 1 or 2, occasionally 3.

Recognition characters

Adult female at full growth robust, with prosoma distinctly broader than postsoma, broadest subbasally; prosomatic tubercles slightly indicated at most; peribuccal scleroses well formed. Anterior spiracles each with a large crescent-shaped group of disc pores; posterior spiracles each also with many disc pores. Perivulvar disc pores numerous. Submarginal dorsal boss, when discernible, small, occurring on abd I and also just mesally to submarginal macroduct row of III. Submedian dorsal macroducts on abd II–VI, present or absent on I; usually divided into segmental and infrasegmental series except on VI, forming a row on VI. Submarginal macroducts on abd III–V, present or absent on II. Lateral macroducts absent except for rare occurrence of a single one on abd III. Lateral gland spines absent on abd II, well represented on III. Marginal gland spines broadly variable in number on abd IV, often more than 1 on V and VI each, 1 or 2, occasionally 3, on VII. Median trullae produced, robust, rounded or conical with apex blunt, obscurely notched several times on each side; basal zygosis robust. Second and third trullae well represented, each with lateral lobule much smaller than the mesal. Marginal processes of abd IV and V low.

Remarks

This species was originally described from an unidentified tree. Later, it was recorded in Japan and continental China on five plant species belonging to four families: in Japan on *Cornus controversa*, *Styrax japonica*, and *Pterostyrax hispida* (Styracaceae) (Kawai, 1980), in Sichuan and Jiangxi on *Cedrella sinensis* (Meliaceae) (Chen, 1983), and in Fujian on *Lagerstroemia indica* (Lythraceae) (Tang, 1986). In the present study, it is formally recorded from Taiwan and from *Symplocos laurifolia*. So far as based on these records, *A. projecta* is a broadly distributed polyphagous species and, accordingly, should be variable also in some morphological features.

The collection localities of the five samples available for the present study are limited to three localities within a narrow area on the Sea of Japan side of central Honsyû [Honshû] (Sample 1–3), a locality on an island lying in the Pacific Ocean off the coast of central Honsyû (Sample 4), and a mountain in northern Taiwan (Sample 5). All these samples are too small to make meaningful comparisons among them.

The samples from Japan, Sample 1–4, have a total of 28 adult females, with which Sample 5 from Taiwan, represented by only two individuals, may be compared not totally without significance. In this comparison, obvious differences exist in the occurrence of dorsal macroducts on abdominal segments, resulting in a great difference in the total number of these macroducts. A definite difference is found in the number of lateral gland spines on the third abdominal segment and also in the number of marginal gland spines on the fourth segment. So far as based on the descriptions, the forms recorded by Chen (1983) and Tang (1986) from southern continental China are different from each other especially in the occurrence and total number of dorsal macroducts. It seems that, in these features, *A. projecta* is considerably variable among local and host plant forms. In this respect, the concept of *A. projecta* adopted in this study is only tentative, being based on the small samples from the limited localities in Japan and Taiwan.

All the samples examined in the present study are referred to the same species mainly on the basis of their agreements in pygidial characters. They agree also in lacking macroducts and gland spines on the lateral lobes of the second abdominal segment

and in lacking macroducts on the lateral lobes of the third segment (except for the rare occurrence of a single macroduct in Sample 1). This pattern in the occurrence of the lateral organs may well characterize the species.

In the characters of the median trullae, *A. projecta* is very similar to *Aulacaspis kadsurae* Takagi and Kawai (Fig. 20), which occurs in central Honsyû and southern Japan in association with vines of *Kadsura* and *Schisandra* (both these genera belonging to the family Schisandraceae). These species are remarkably different in the presence or absence of dorsal and lateral macroducts on abdominal segments and in the numbers of gland spines. In the second instar female, *A. projecta* is usually provided with single marginal macroducts on the fourth to seventh abdominal segments and single submarginal macroducts on the third to fifth segments (based on the samples from Japan), whereas *A. kadsurae*, while having single marginal macroducts on the third to seventh abdominal segments, lacks submarginal macroducts.

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Fig. 1. *Aulacaspis connari*, adult female, full-grown. Luzón, on *Connarus semidecandrus* leaf. B, posterior spiracle; C, posterior spiracle in another individual; D, marginal processes on abd IV and V; E, median trullae; F, antenna; G, anterior spiracle; H, peribuccal sclerosis; I, lateral lobe of abd III, ventral surface; J, trullae. Scale bars: 100µm for A; 10µm for B–D, F–J; 5µm for E.

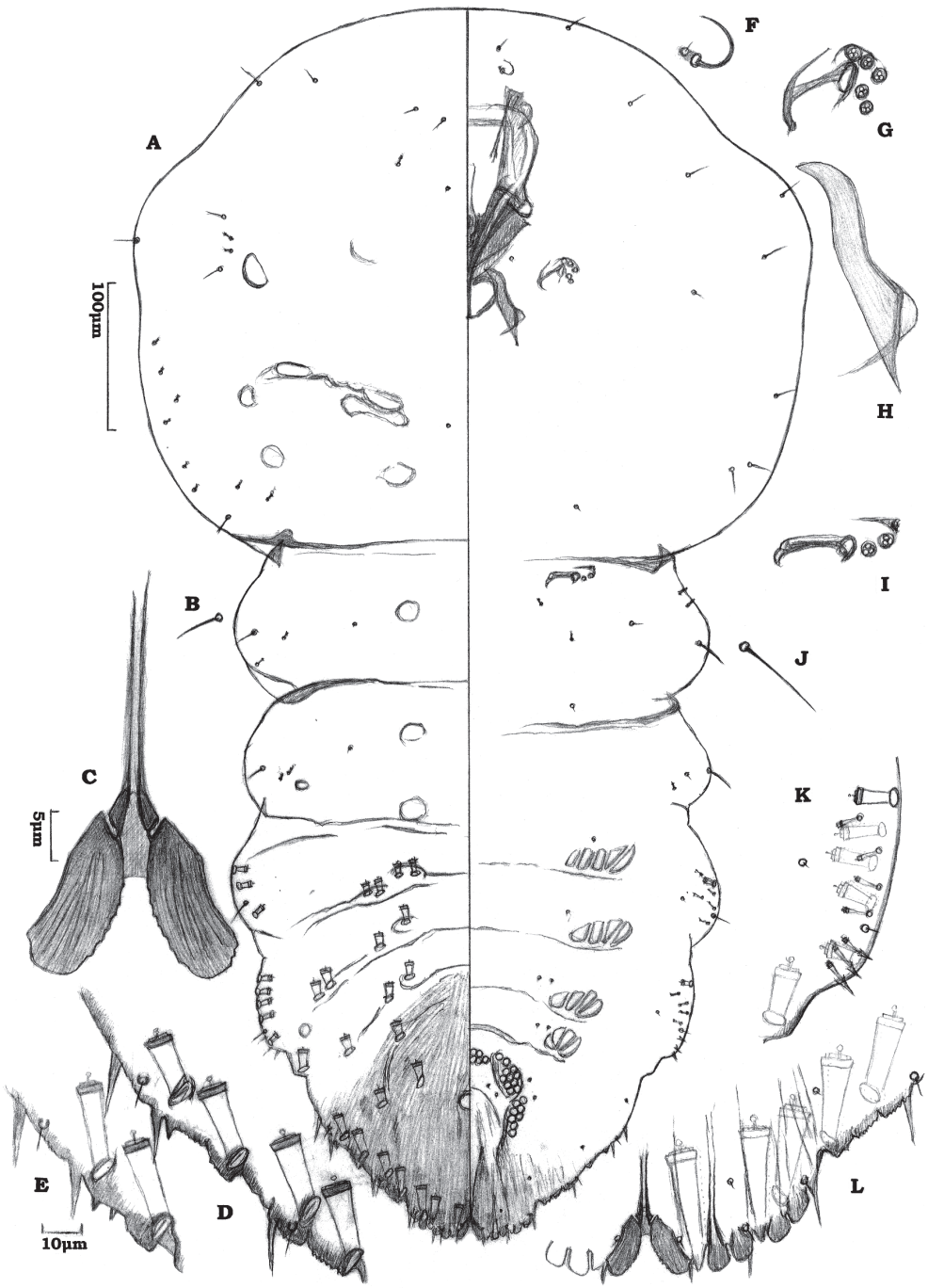

Fig. 2. *Aulacaspis swintoniae*, adult female, full-grown. Sample 1: Penang Is., Malaya, on *Swintonia floribunda* leaf. B, marginal seta on dorsal surface of metathorax; C, median trullae; D, marginal processes on abd IV and V; E, margin of abd IV in another individual; F, antenna; G, anterior spiracle; H, peribuccal sclerosis; I, posterior spiracle; J, marginal seta on ventral surface of metathorax; K, lateral lobe of abd III, ventral surface; L, trullae. Scale bars: 100µm for A; 10µm for B, D–L; 5µm for C.

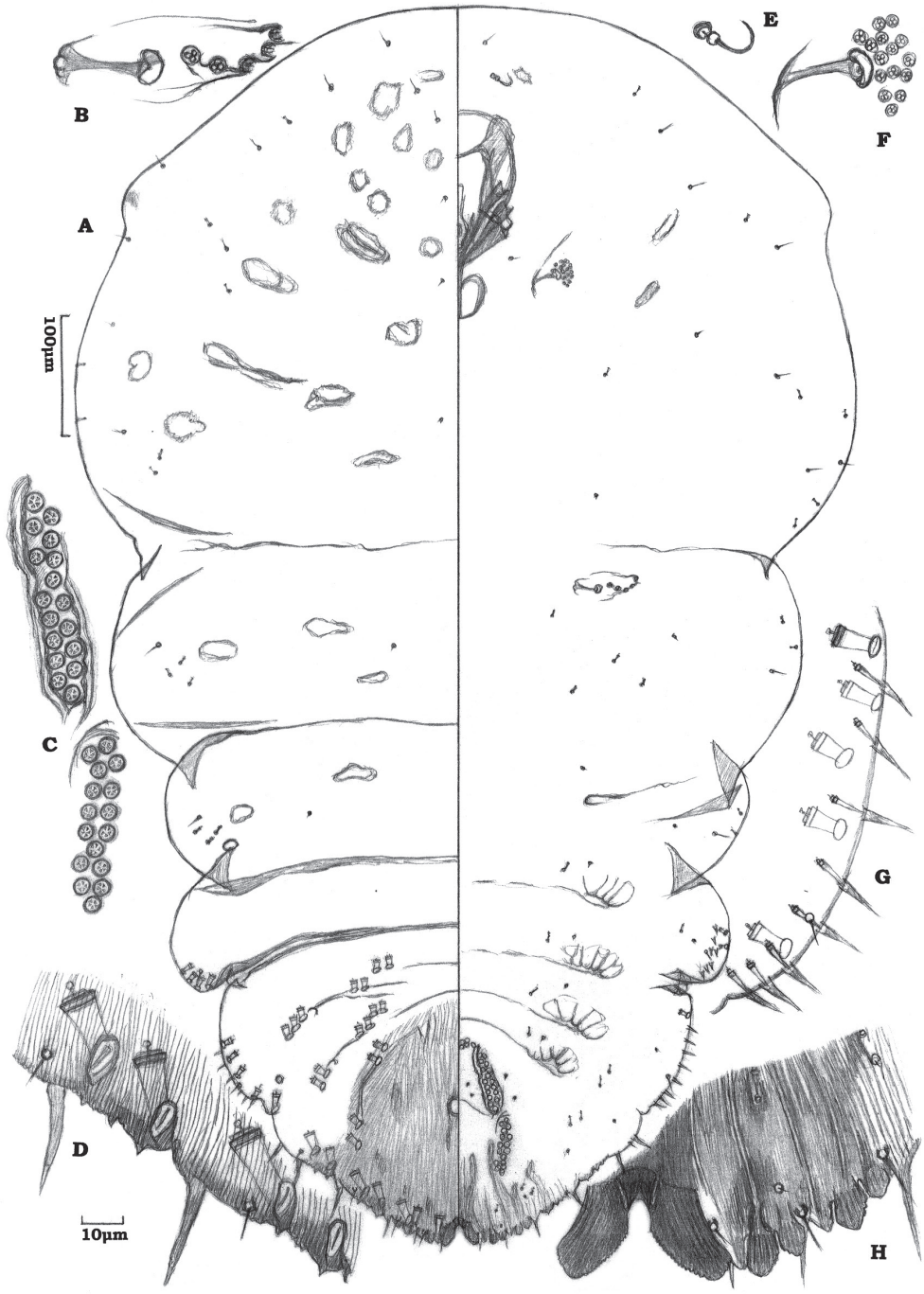

Fig. 3. *Aulacaspis nephelii*, adult female, full-grown. Malaya, on *Scurrula ferruginea* twig. B, posterior spiracle; C, perivulvar disc pores in antero- and posterolateral groups; D, marginal processes on abd IV and V; E, antenna; F, anterior spiracle; G, lateral lobe of abd III, ventral surface; H, trullae. Scale bars: 100µm for A; 10µm for B–H.

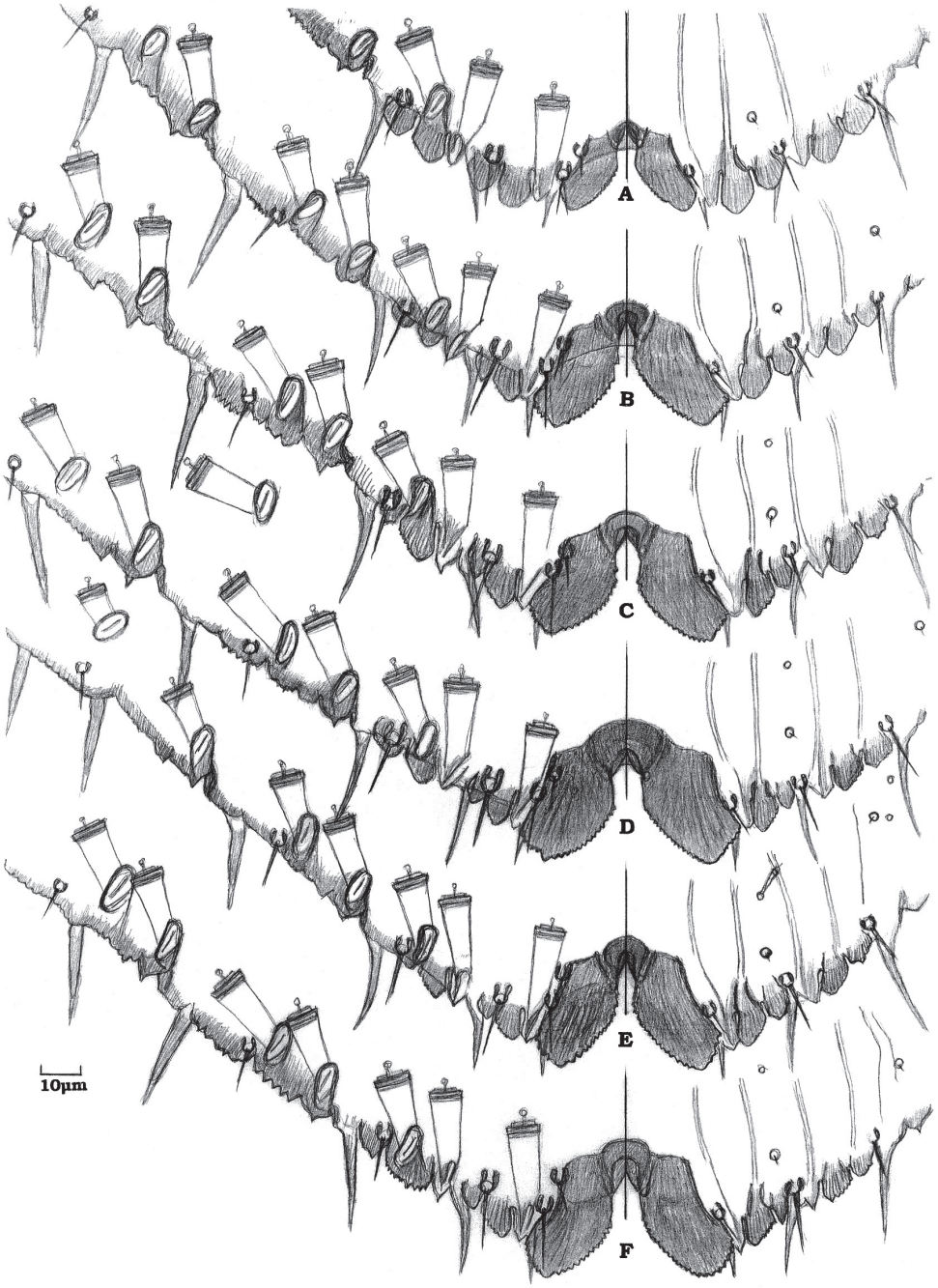

Fig. 4. *Aulacaspis nephelii*, adult females, pygidial margins. Malaya, on *Scurrula ferruginea*. A–D, on leaf; E, F, on twig. Scale bar, 10µm for A–F.

Fig. 5. *Aulacaspis buteae*, adult female, full-grown. Kathmandu Valley, on *Lespedeza* (?) sp. branch. B, posterior spiracle; C, enlarged microducts on dorsal surface of prothoracic area; D, enlarged microducts on dorsal surface of abd I; E, marginal processes of abd IV and V; F, antenna; G, anterior spiracle; H, lateral lobe of abd III, ventral surface; I, trullae. Scale bars: 100µm for A, 10µm for B–I.

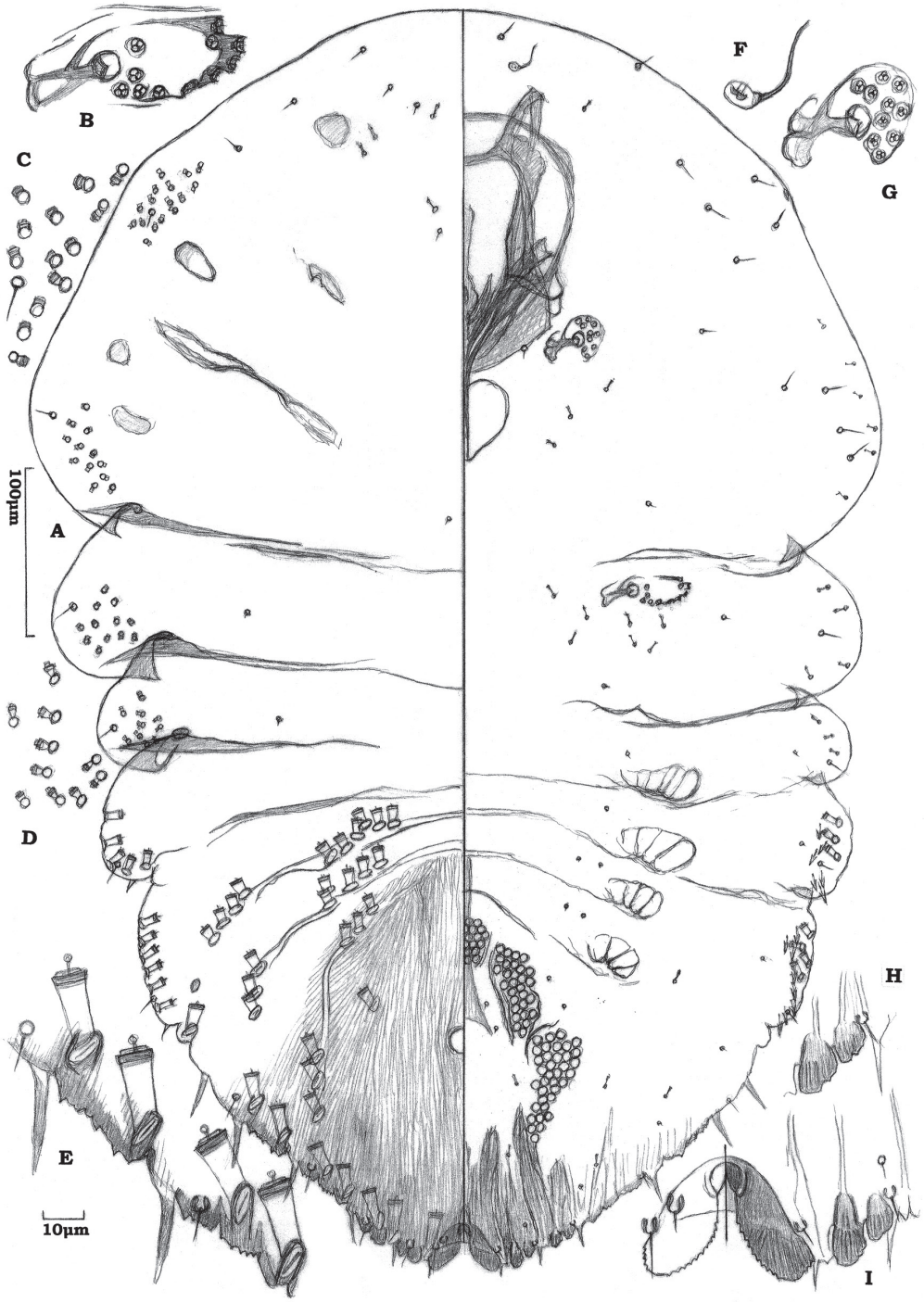

Fig. 6. *Aulacaspis buteae*, adult female, teneral. Kathmandu Valley, on *Lespedeza* (?) sp. branch. B, posterior spiracle; C, enlarged microducts on dorsal surface of prothoracic area; D, enlarged microducts on dorsal surface of abd I; E, marginal processes on abd IV and V; F, antenna; G, anterior spiracle; H, third trulla; I, median and second trullae. Scale bars: 100µm for A; 10µm for B–I.

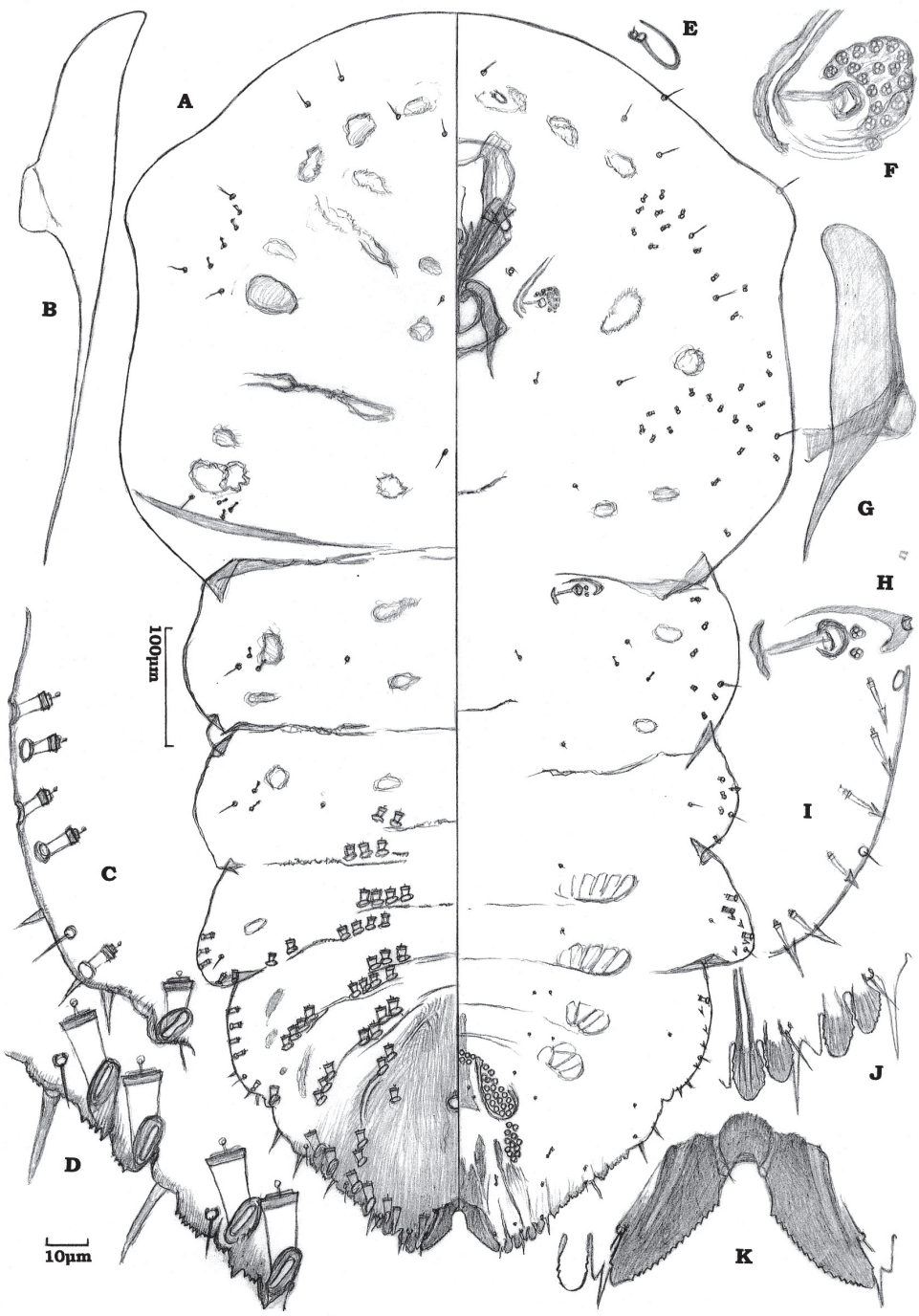

Fig. 7. *Aulacaspis connarorum*, adult female, full-grown. Sample 3: Kuantan, Malaya, on *Connarus ferrugineus* leaf. B, peribuccal sclerosis; C, lateral lobe of abd III, dorsal surface; D, marginal processes on abd IV and V; E, antenna; F, anterior spiracle; G, peribuccal sclerosis opposite B; H, posterior spiracle; I, lateral lobe of abd III, ventral surface; J, lateral trullae; K, median trullae. Scale bars: 100µm for A; 10µm for B–K.

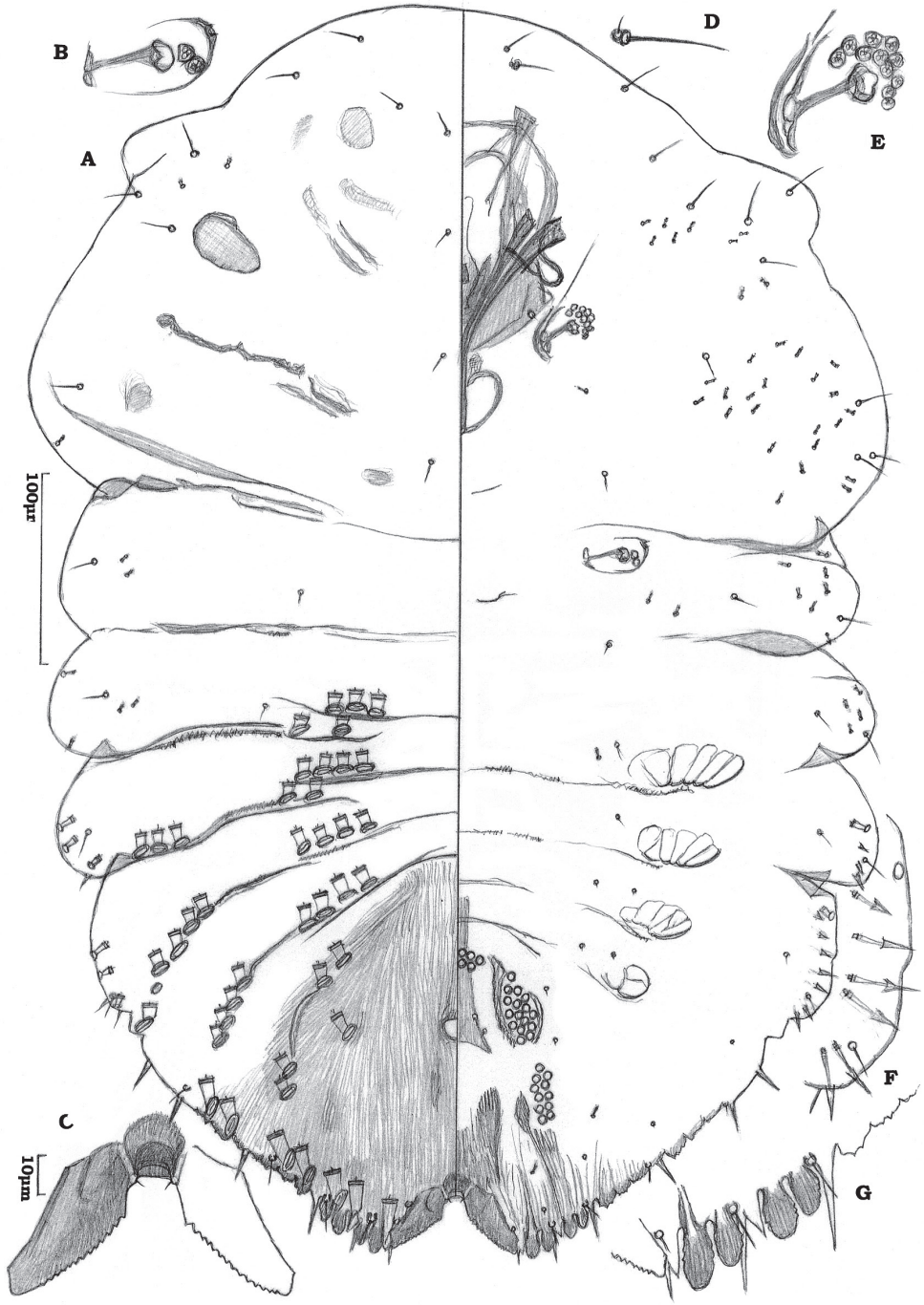

Fig. 8. *Aulacaspis connarorum*, adult female, teneral. Sample 3: Kuantan, Malaya, on *Connarus ferrugineus* leaf. B, posterior spiracle; C, median trullae; D, antenna; E, anterior spiracle; F, lateral lobe of abd III, ventral surface; G, lateral trullae. Scale bars: 100µm for A; 10µm for B–G.

Fig. 9. *Aulacaspis bauhiniae*, adult female, full-grown. Mt. Kinabalu, Sabah, on *Bauhinia* sp. leaf blade. B, posterior spiracle; C, marginal processes on abd IV and V; D, antenna; E, anterior spiracle; F, lateral lobe of abd III, ventral surface; G, trullae. Scale bars: 100µm for A; 10µm for B–G.

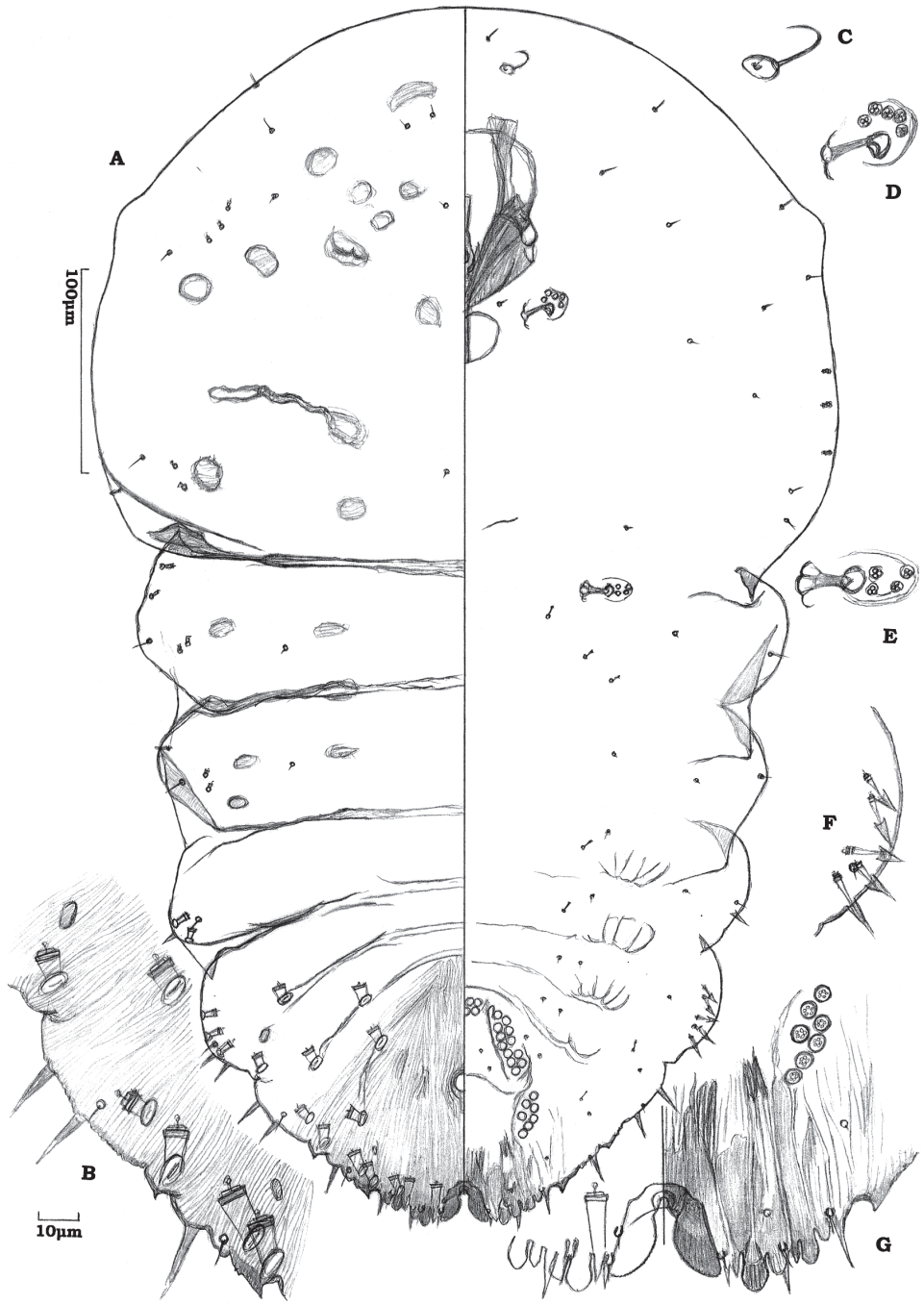

Fig. 10. *Aulacaspis phanerae*, adult female, full-grown. Sample 2: Bako National Park, Sarawak, on *Bauhinia excelsa* leaf blade. B, marginal processes on abd IV and V; C, antenna; D, anterior spiracle; E, posterior spiracle; F, lateral lobe of abd III, ventral surface; G, trullae. Scale bars: 100µm for A; 10µm for B–G.

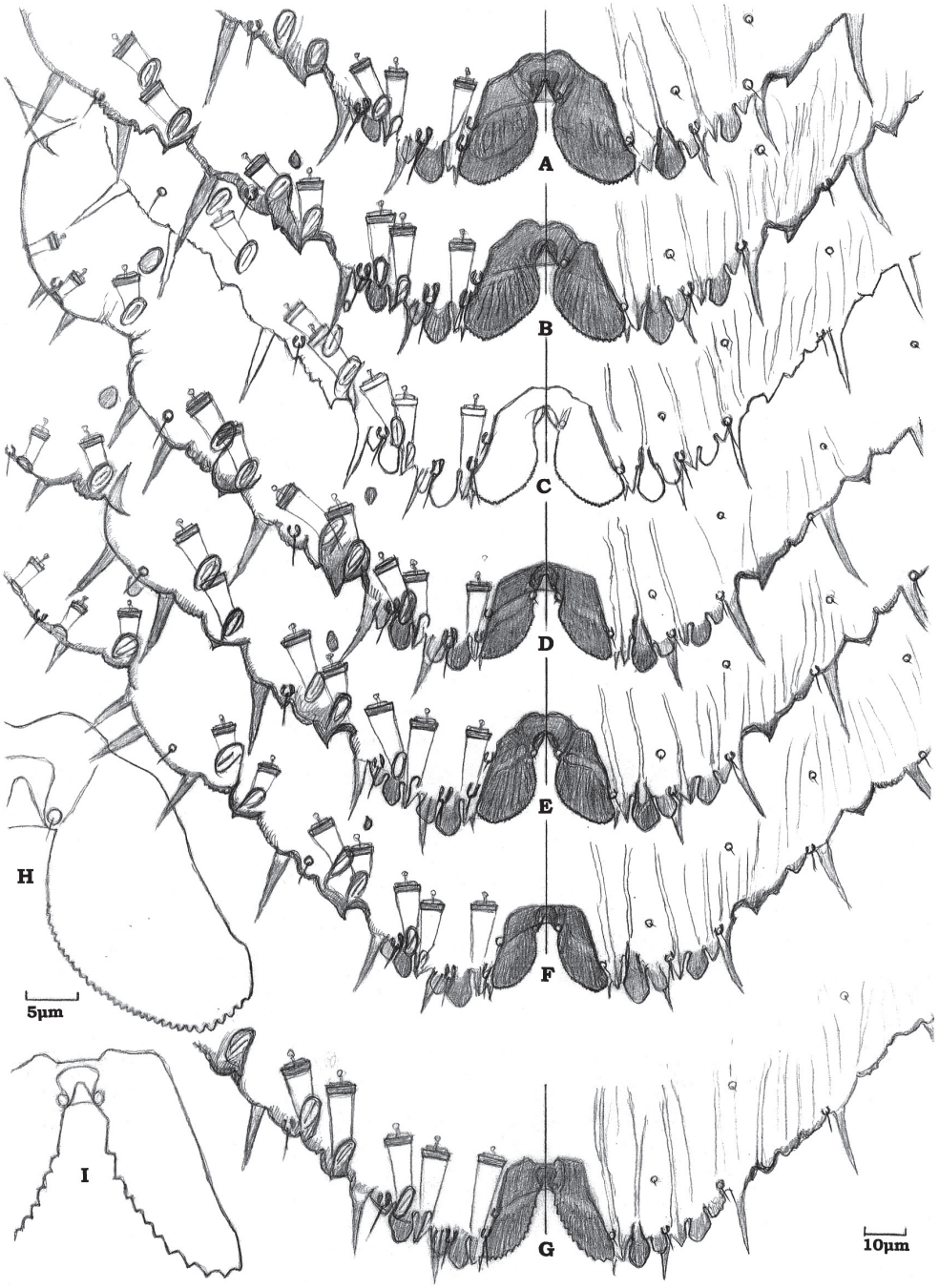

Fig. 11. *Aulacaspis bauhiniae*, adult female (G, I). Mt. Kinabalu, Sabah, on *Bauhinia* sp. leaf blade. G, pygidial margin; I, outline of median trulla. *Aulacaspis phanerae*, adult females (A–F, H). Bako National Park, Sarawak, Sample 1: on *Bauhinia* sp.; Sample 2: on *Bauhinia excelsa*. A–F, pygidial margins; H, outline of median trulla. A, B, H, Sample 1, petiole; C, D, Sample 1, leaf blade; E, F, Sample 2, leaf blade. Scale bars: 10µm for A–G; 5µm for H, I.

Fig. 12. *Aulacaspis robusta*, adult female, full-grown. Sample 1: Taiwan, on *Ardisia sieboldii* branch. B, anterior spiracle; C, posterior spiracle; D, antenna; E, peribuccal sclerosis; F, third trulla; G, median and second trullae. Scale bars: 100µm for A; 10µm for B–G.

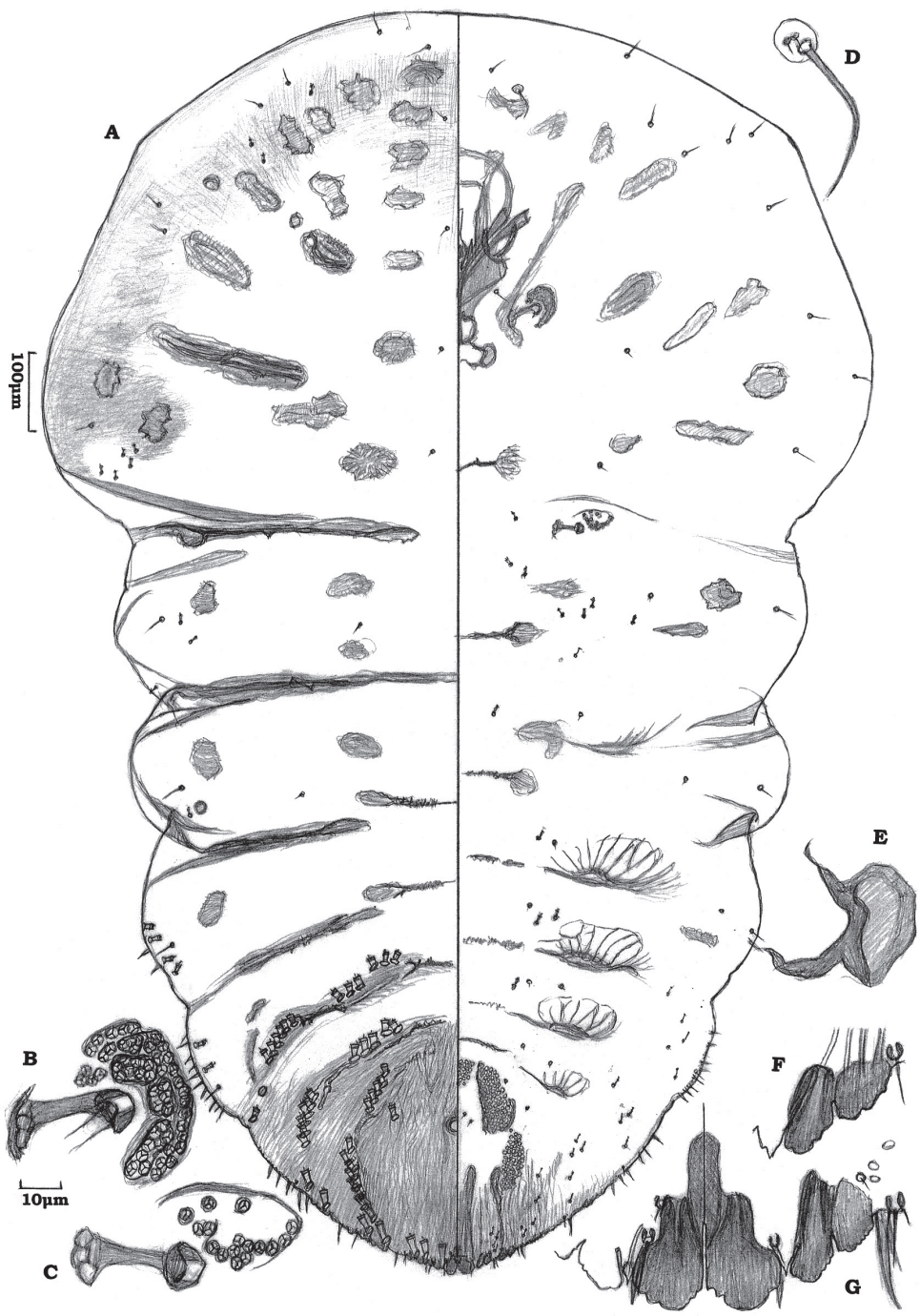

Fig. 13. *Aulacaspis robusta,* adult female, premature. Sample 1: Taiwan, on *Ardisia sieboldii* branch. B, anterior spiracle; C, posterior spiracle; D, antenna; E, peribuccal sclerosis in a stage of growth; F, third trulla; G, median and second trullae. Scale bars: 100µm for A; 10µm for B–G.

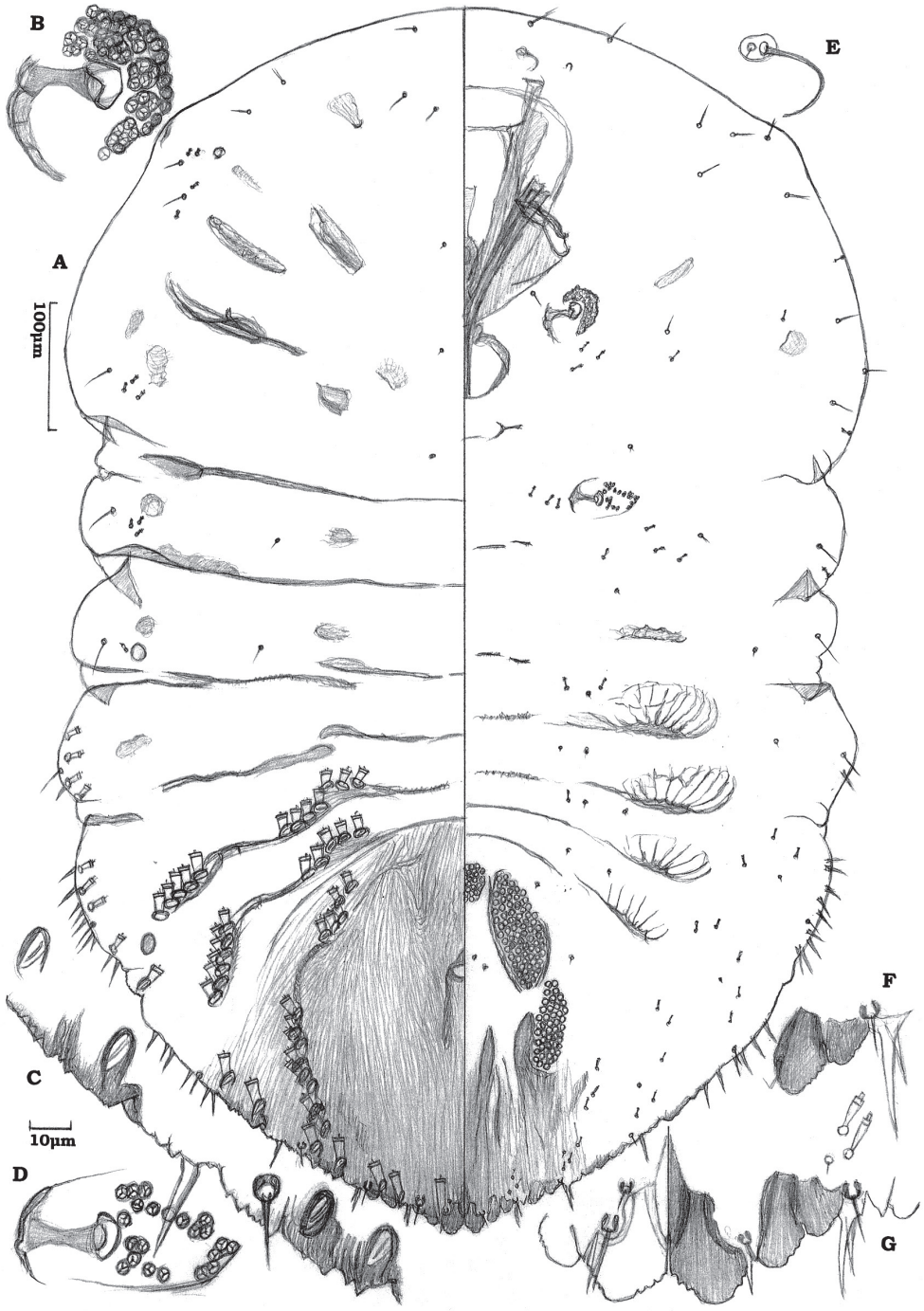

Fig. 14. *Aulacaspis robusta*, adult female, teneral. Sample 1: Taiwan, on *Ardisia sieboldii* branch. B, anterior spiracle; C, marginal processes on abd IV and V; D, posterior spiracle; E, antenna; F, third trulla; G, median and second trullae. Scale bars: 100µm for A; 10µm for B–G.

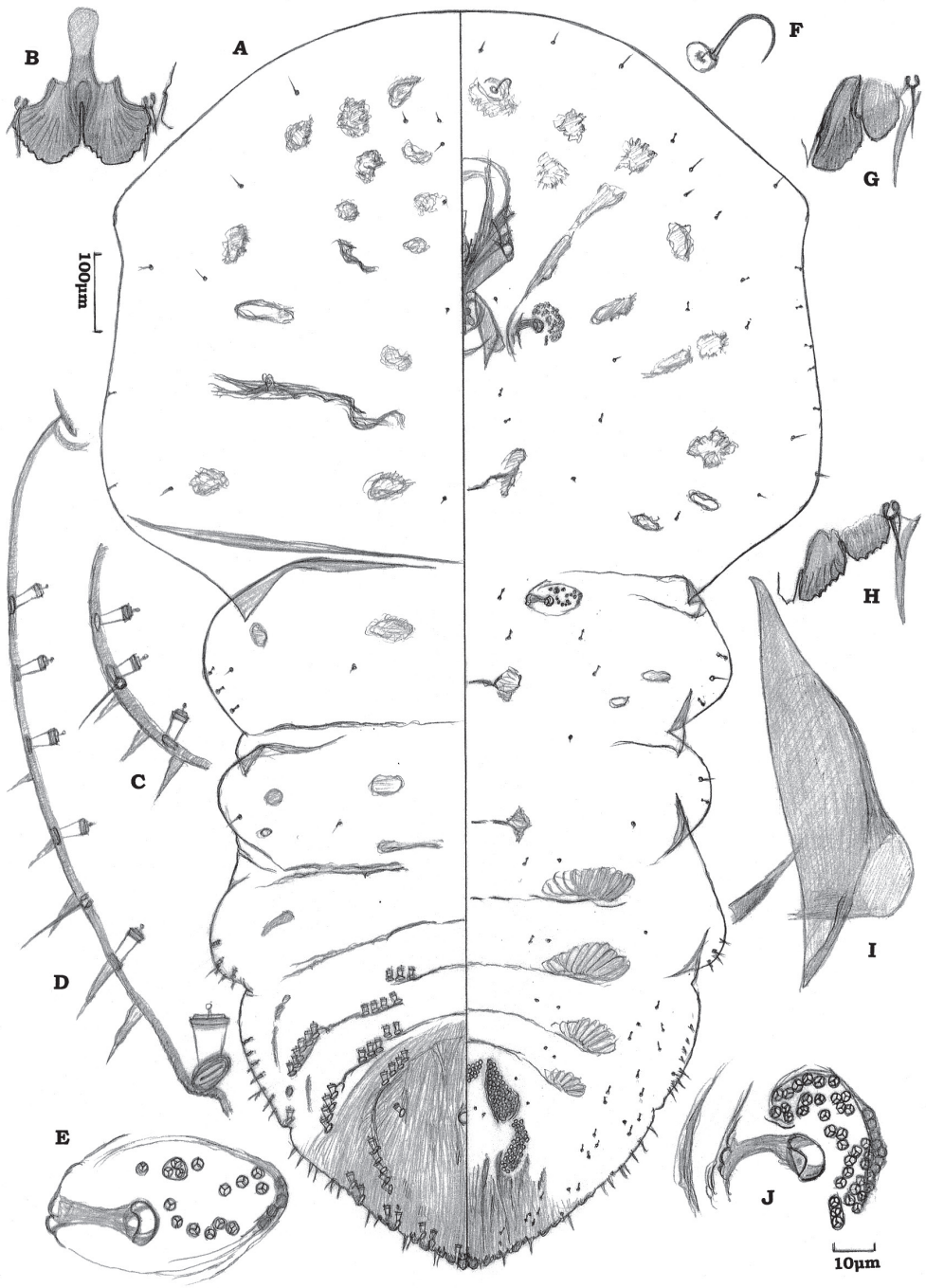

Fig. 15. *Aulacaspis robusta*, adult female, nearly full-grown. Sample 2: Sarawak, on *Ardisia* sp. branch. B, median trullae; C, lateral lobe of abd II, dorsal surface; D, lateral lobe of abd III, dorsal surface; E, posterior spiracle; F, antenna; G, second trulla; H, third trulla; I, peribuccal sclerosis; J, anterior spiracle. Scale bars: 100µm for A; 10µm for B–J.

Fig. 16. *Aulacaspis robusta*, adult female. Sample 2: Sarawak, on *Ardisia* sp. branch. A, pygidium; B, pygidial margin; C, pygidial margin in another individual. Scale bars: 100μm for A; 10μm for B, C.

Fig. 17. *Aulacaspis projecta*, adult female, full-grown. Sample 1, type series: central Honsyû, on an unidentified tree, branch. B, posterior spiracle; C, lateral lobe of abd III, dorsal surface, part; D, marginal processes on abd IV and V; E, anterior spiracle; F, antenna; G, third trulla; H, median and second trullae. Scale bars: 100µm for A; 10µm for B–H.

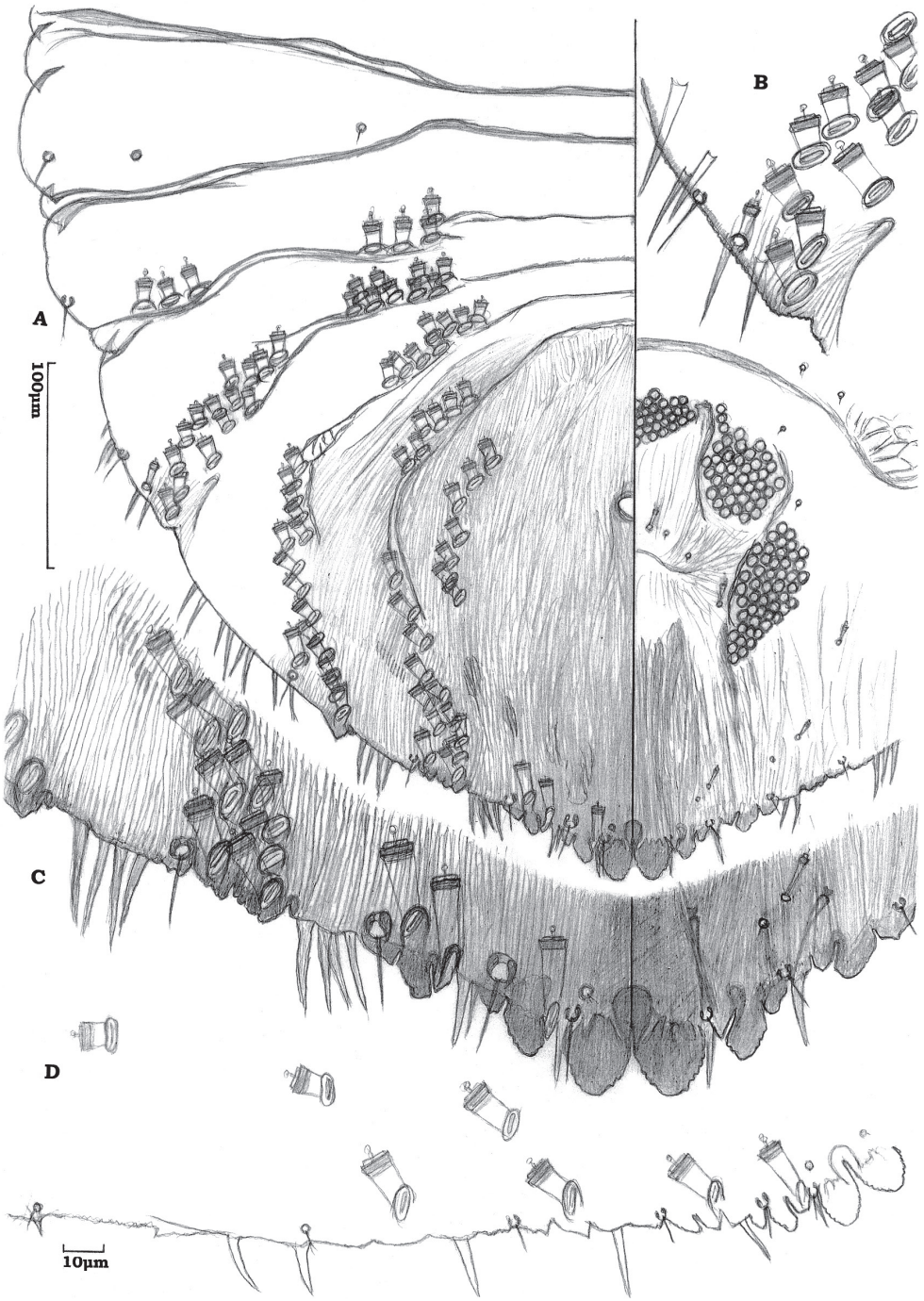

Fig. 18. *Aulacaspis projecta*, adult female (A–C) and second instar female, exuvial cast (D). Sample 1, type series: central Honsyû, on an unidentified tree, branch. A, pygidium; B, lateral lobe of abd III, dorsal surface; C, pygidial margin; D, pygidial margin in second exuvial cast. Scale bars: 100μm for A; 10μm for B–D.

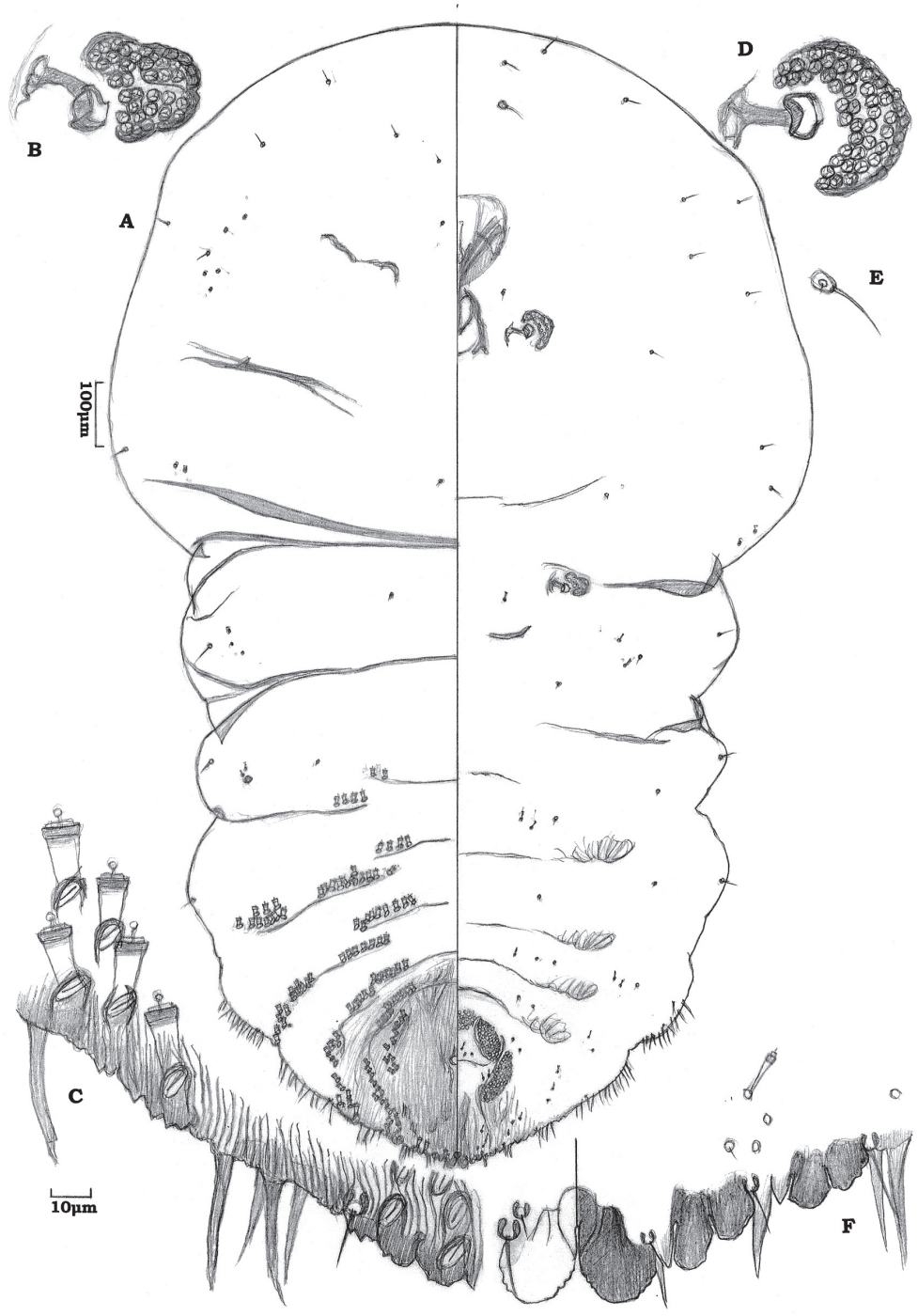

Fig. 19. *Aulacaspis projecta*, adult female, full-grown. Sample 5: Taiwan, on *Symplocos laurifolia* branch. B, posterior spiracle; C, marginal processes on abd IV and V; D, anterior spiracle; E, antenna; F, trullae. Scale bars: 100μm for A; 10μm for B–F.

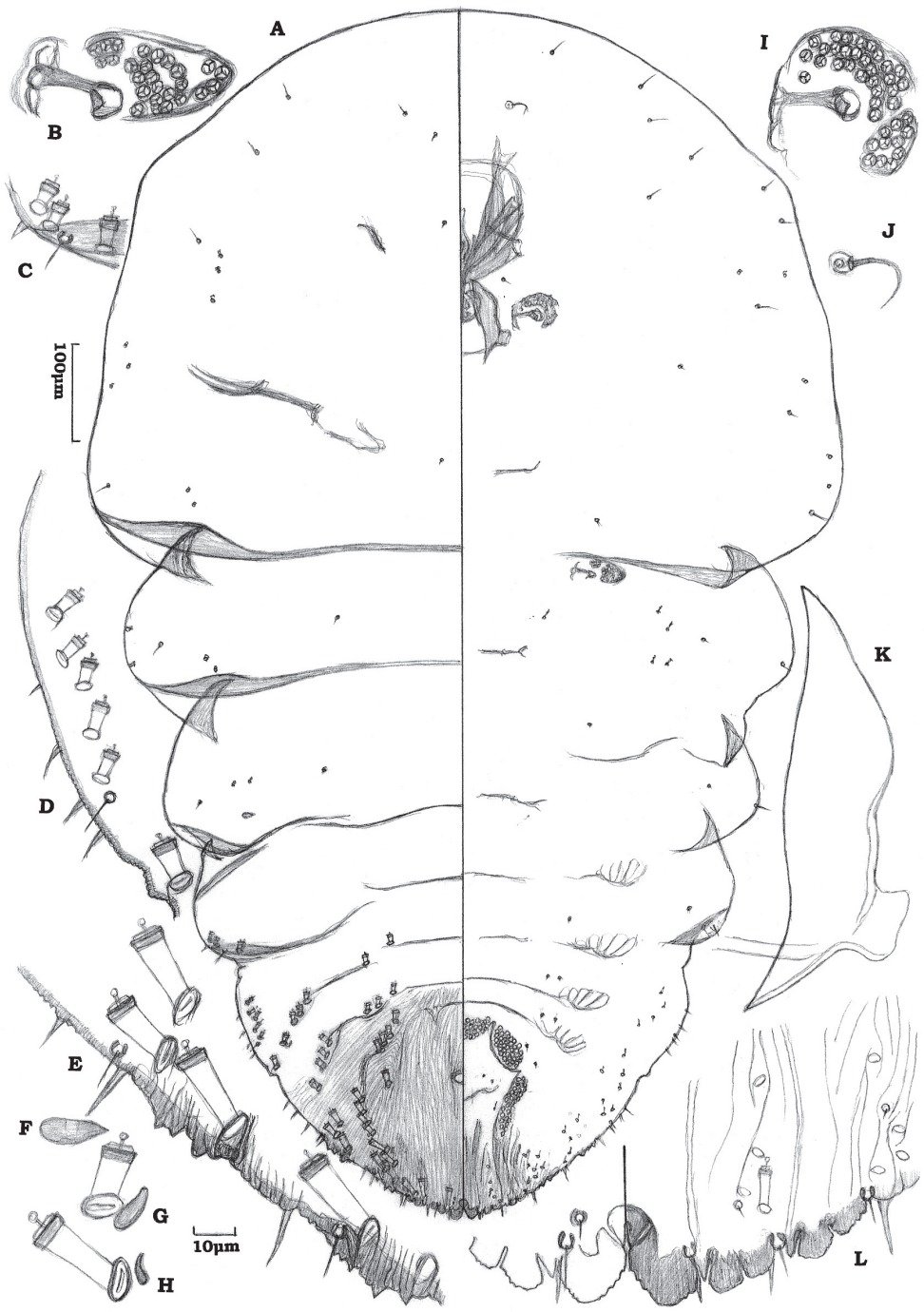

Fig. 20. *Aulacaspis kadsurae*, adult female, full-grown. Mounted from part of the type material: Kii Peninsula, Honsyû, on *Kadsura japonica* stem. B, posterior spiracle; C, lateral lobe of abd II, dorsal surface, part; D, lateral lobe of abd III, dorsal surface; E, marginal processes on abd IV and V; F, G, H, dorsal boss on abd I, III, V, respectively; I, anterior spiracle; J, antenna; K, peribuccal sclerosis; L, trullae. Scale bars: 100μm for A; 10μm for B–L.